375.57
L63p

LIBRARY
OF THE
UNIVERSITY OF ILLINOIS

PUBLIC SCHOOLS

NATURE STUDY

LINCOLN, NEBR.

THE LIBRARY OF THE
OCT - 5 1933
UNIVERSITY OF ILLINOIS

LIBRARY
OF THE
UNIVERSITY OF ILLINOIS

Henry B. Ward

THE UNIVERSITY
OF ILLINOIS
LIBRARY

PUBLIC SCHOOLS

NATURE STUDY

LINCOLN, NEBR.

THE LIBRARY OF THE
OCT - 5 1933
UNIVERSITY OF ILLINOIS

Digitized by the Internet Archive
in 2017 with funding from
University of Illinois Urbana-Champaign Alternates

https://archive.org/details/publicschoolsnat00linc

375.57
L63p

To the Teachers:

The following is an outline of graded lessons from which selections may be made by teachers according to their circumstances. It is expected that the language and spelling work will take the form of nature work or, perhaps better, that the material for language and spelling will come from this nature study. The number work, also, will be made to depend upon the nature study as far as possible. (See Jackman's Number Work in Nature Study.)

It will be profitable for the teacher to visit the laboratories and museums of the State University and, occasionally, to take her class with her, but not unless all have a serious purpose in it.

Nature work must be presented and carried out in a plain, homely fashion, entirely without technicality in the lower grades, or anything that can in any way detract from the simplicity of the work. *Teachers are especially warned about this matter.* The outline of work here presented is not for the use of pupils, and any technical matter contained herein, with very few exceptions, is not to be given to the pupils, but is for the guidance of the teacher.

Teachers are not required to do all the work indicated, but must make a selection of work for each grade according to the needs and capabilities of the class. The choice must be made, however, from the work outlined for that particular grade. Therefore when a class is promoted or changed from one room to another, it will be necessary for the teacher to send with the class a *carefully written statement as to what and how much work has been done.*

It will be noticed that, as the regular language and spelling work is to depend in great measure upon the work here outlined, note books must be continually used in connection. Therein will be the great value of this work to written language. The pupil must be required to have a neat, well written book, and it must contain correctly constructed, complete, and well spelled sentences.

The Nature Study here presented is divided as follows: I. Plants (Autumn.) Minerals (Winter.) Plants (Spring.) II. Animals (whole year.) III. Natural Phenomena (whole year.) There is work outlined for each grade, and it is desired that the parts I, II and III be carried forward simultaneously; they have been printed separate only that we may get a better idea of the continuity of each branch of work. They all must be closely associated with geography, especially, with one another, and with other studies as

914194

far as possible. Strive for a complete unification of studies, each in its due proportion.

The work is based upon, and partially reprinted from, the Scheme for Nature Study prepared by Arthur C. Boyden, of Bridgewater, Mass., who has been kind enough to consent to its use. It also, as far as plants are concerned, follows very closely the report by Dr. C. E. Bessey to the committee of the National Educational Association on Course of Study for Secondary Schools. We are all under obligations to these gentlemen, as well as to Professors Bruner and Ward of the State University for assistance in adapting the work on animals to this region.

In the appendix will be found a list of books in the teachers' and city libraries that will be of assistance to both pupils and teachers in the nature work.

F. STRONG,
Superintendent.

December 30, 1893.

NATURE STUDY.

I PLANTS.

(AUTUMN.)

First Year. The children should continue their familiarity with nature as they enter the schoolroom. Action and conversational lessons to increase their interest and appreciation, and, also, for oral language. A large portion of the early reading should be based on the observation of objects of nature, sentences given by the children copied as stories of their observation.

Outline. (The figures that follow indicate the number of different specimens to be brought by each pupil.)

Grasses (3), Green Slime (1), Pond Scum (1), Rust (1), Moss (1), Trees (5), Shrubs (5), Lichen (1).

Plants. Wild flowers of the fall growing in soil, cared for by the children, recognize and name a dozen or more flowers, habits of the plants as they grow; colors of the root, leaves and flowers; size and shape of the parts, lead them to see the fitness of each to each, that each part is made to be helpful to another part, and that each increases the power of the other: uses of the roots, stem, leaves, and flowers to the plant, to insects, and to man.

Fruits. Peach, apple, grapes, acorns, cones, etc.; where they grow, color, covering to protect, soft part, core, seeds; compare the fruit, show that each part has its use and work, use of the fruit to the seeds, to animals, and as food for man. Seeds have life, when protection is no longer needed fruit decays. Collect different seeds and name them, mold fruits and seeds in clay, mount and sketch for busy work.

Autumn leaves. Recognize the trees by leaf, colors, shape and sizes of leaves, use in teaching words long, short, broad, narrow, thick, thin, etc. Formation of leaf buds, position of the same. Press for winter use, mount and sketch, with simple copied sentences.

Number work. Use natural objects as far as possible, *e. g.*, two cups to the flower, leaves at each joint, petals in the flower, seeds in

the fruit, collections of nuts, seeds, leaves, etc., from which children select material; eyes, ears, legs, wings, toes, etc., of animals; mount objects representing problems.

Language. Oral at first, conversation lessons; then read and copy names of plants and sentences containing action and quality words. Point out and name parts of many plants; find qualities, habits and uses of plants, and use in simplest manner for language lessons.

Vary work from day to day; short lessons given to small groups are best; teach new words as part of reading lesson.

Second Year.

Outline. Grasses (2), sedges (1), other herbs (3), fern (1), toadstools (2), puffballs (2), rust (1), herbs (house plants) (6).

Observation of the *parts* of natural objects, simple qualities which distinguish these parts, their uses to the plant or animal in protecting it or providing for its needs, uses to man. Comparison of objects not too near alike.

September. Recognition of ten to twenty common fall flowers, *e. g.*, clover, golden rod, evening primrose, wild morning glory, ground cherry, dandelion, wild indigo, asters, etc.

Prepare the children to give an oral or written description from series of questions or headings written on the board, varying the form for different plants. Suggestive points for the lessons:—Where have you seen it growing? How high does it grow? Tell about the roots, where they grow. Fibres—color, number, tapering, rootlets, use to the plant in holding it and getting water for it, why it needs so many fibres. Leaves—where they grow, how many at a joint, general shape. any peculiarity. Flowers—color, size, where they grow on the plant and why; separate or in clusters; of single flowers —petals and sepals, form and number, for protecting other parts, beauty, attracting insects; stamens and pistils to form the seed. Compare the flowers for oral language work, *e. g.*, wild verbena, cultivated verbena, evening primrose, dodder, clover and golden-rod, where grow, color, clusters, leaves, color of flowers, number of parts to flowers, shape of the parts.

Sketching for busy work to show the number and arrangement of the parts on the plant, and something of their form, color with pencils to give the appearance of life. Selections for oral and silent reading about the wild flowers, selections from standard authors written and memorized. (Fairyland of Flowers, How to Know Wild Flowers.)

October. Observation of leaves of the different trees, recognize

from ten to twenty different trees, noticing where they grow. Use twigs with leaves attached; teach parts of leaves, apply to many illustrations.

Parts { petiole—to hold leaf on stem.
blade { skin—thin, to protect the leaf.
skeleton—to support the leaf—midrib, veins.
pulp—soft part, between veins.

Observe how the petiole clasps the stem, its shape, trace it into the leaf to the points or edge. Let child describe selected leaves, noting what he sees of size, color, shape, number of principal veins, surface. Compare two leaves for the same points, noticing the arrangement on the stem, *e. g.*, elm, maple, oak, cottonwood, catalpas, sycamore, ash, etc. Derive the uses of the trees, beauty, shade, wood, etc. Teach the differences in apex, margin, and base by sketching sets of leaves, pressing and mounting autumn leaves that are alike, and sets showing the differences. Select reading lessons about trees.

November. Notice the trees which shed their leaves in autumn, and those which keep them on during the winter. Note other changes which show that winter is coming, *e. g.*, birds, insects, fruits, small plants dying to the ground, preparations of people for winter, changes in temperature, rising and setting of sun. Look for the first frost, where, how disappear. injury done, what is the frost ?

Fruits. Observation, description, and sketching of section of a few typical fruits, *e. g.*, apple, grape, acorn. Apple—stem and blow, what; skin to cover it, color; pulp, color, juice, use; core, number of parts, use; seeds, color, hardness, use. Sketch a cross and a longitudinal section, write a description or a story. Compare the apple and grape. Acorn—where it grows, parts; cup—shape, color, inside and outside; nut—shape, color of shell, use of shell; kernel—parts, skin, color, taste, use as food for animals. Select reading lessons on fruits, and squirrels collecting nuts for winter. Collect dry fruits and seeds, recognize a large number.

Language Work. Conversational lessons on the parts of a few of these plants, followed by oral and written descriptions, the teacher writing the new words as used on the board (spelling), keeping simple record of change in flowers and trees in the autumn.

The language work should be mainly narrative in form: (1) simple description; (2) imaginative description; (3) stories of uses of the parts; (4) comparison. These exercises may be used in teaching singular and plural forms, possessive singular form.

Third Year.

Outline. What plants are in bloom? How late do any plants

remain in blossom? When do trees drop their leaves? When do plants die from frost? *Late autumn*—what plants are still alive? What is the condition of common herbs, (sunflowers, milkweeds, grasses, clovers, etc.?) of common trees, evergreen trees?

September. Recognition of 10-20 common flowers, where they grow, and color of flowers, *e. g.*, petunia, evening primrose, prairie clover, dodder, verbena, cultivated and wild; ground cherry, wild morning-glory, wild indigo, such composites as dandelion, golden-rod, asters, yarrow, sunflower, etc. Describe the size, shape, color and arrangement of the flowers, compare two flowers that are quite different, (do not use technical names with the children.) Distinguish calyx, corolla, stamens, and pistils, with the general use of each to the plant. Compare composites to notice the small flowers in a head, often with other flower leaves around so as to look like one large flower, think how this helps the insects. Sketch the plant to accompany the description, color with pencil to give appearance of life. Write a letter describing the places where the wild flowers grow, or those seen on the way to school. Encourage pupils in pressing and mounting an herbarium. Select reading lessons on flowers, memory gems.

October. Recognition of ten to twenty common trees, keep specimens in water or press for mounting, prepare lists of trees known, separating evergreens from deciduous trees. More extended observation of leaves, studying twigs for arrangement of leaves, *e. g.*, compare maple and elm leaves for ideas of opposite and alternate, mount and write, make lists from outside observation; examine the veins of a leaf, sketch, compare grass leaf and maple, distinguish parallel and netted veined, notice that the shape of the leaf depends on the veining, describe each leaf, using simple terms to describe the shape, make collections of each kind, trace the veins in oak and maple for ideas of feather veined and palm veined, note how the shape of the leaf depends on the veining, sketch and write a comparison, collect examples of each kind; a clover leaf, notice the leaflets and how the veins are arranged, compare with some simple leaf, sketch, describe a cotton-wood leaf for busy work. Arrange a set of leaves to show the gradation from simple to compound leaves. Lead the children to see that the shape and arrangement of leaves are adapted to give to each leaf sunshine and air. Select reading lessons on trees or leaves, memory gems, stories of noted trees. (Newell's Botany, Part 1. Our Native Trees.)

November. Watch effects of frost upon trees, shrubs, leaves, etc. Notice condition of buds, how nature prepares plant life for winter.

Language. Many short written exercises as well as oral descriptions following general plan of Second Grade. Use these exercises in teaching spelling of new words, singular and plural forms, possessive singular forms, use of verbs, pronouns, etc., and for whatever else may come in the language course. Originate simple descriptive sentences from questions on the board and teach to combine these sentences. Encourage mounting and sketching.

Use the different kinds of sentences, imaginative stories on growth and habits, use of quotation marks, use of a series of words, irregular forms of grow, blow, etc.

Fourth Year.

Begin the work of grouping natural objects, thinking of the uses to man, and the geographical relations. Writing descriptions according to a series of topics, imaginative stories, ("Story of an Apple," "Story of Grains of Sand," "Story of a Spring,") select words for spelling from these lessons, exercises rewritten for correction.

Outline. Where are particular grasses found? Sedges? Mosses? Sunflowers? Where are particular trees found? Herbs? Shrubs?

September. Examine the stamens and pistils of the common wild flowers, notice the number and position in the flower, the pollen on the end of the stamen, the way in which it can get to the pistil, watch insects on flowers and think how they can carry the pollen. Find the parts of the pistil. Pick apart a flower. Sketch the parts singly and write a short description according to topics. (Grant Allen's "Color of Flowers.")

Examine some pistils which are changing into fruits, make a cross section, find that the ovary is becoming the fruit, and the ovules are the seeds. Sketch and write the story of a pistil. Reading and memory gems about the wild flowers. Selections from "Child's Book of Nature," Hooker.

October and November. Simple lessons on grasses—collect a variety of specimens, tie the grasses in bundles, giving common name if possible and locality. Observe the distinguishing marks—roots, fine or coarse, straight or spreading, few or many (form a turf); stem, length, shape, inside, kind of joints. distance apart, (lightness and stiffness); leaves, simple or compound, opposite or alternate, shape, veins, peculiar way of attachment to the stem (adaptations,) surface, action of dew and rain on the leaves; flowers, how arranged, how many scales at the base of each flower, of same or different size; fruit and seed rich in albumen, used as food, why? Show underground stems of some grasses and way of growth. Other useful members of this group—grains, make collection of grain stalks.

Compare the corn with grasses, roots, pithy stem, leaves, position of flowers and fruit. Show that it is similar to them. In the geography of the year show adaptation to climate—grasses and grains in temperate regions, sugar cane, bamboo and special grasses in the hot regions; make globe maps indicating the leading localities.

Write a letter or description telling of the changes going on in preparation for winter, *e. g.*, migration of birds, insects, etc., going into the ground, squirrels, etc., storing food, leaves dropping, small plants dying to the ground, etc. From reading and pictures compare the cold and hot regions with our own in these winter changes.

Language. Continue language work of previous years in an improved form. Have many short written exercises and oral descriptions. Use these to supply material for the work laid down in the language course. Teach the forms necessary to use in the description of plants for this grade.

Make collections of dry fruits and seeds to see provision of nature for protection and distribution, and for use for written exercises.

Fifth Year.

Observation of groups of plant forms with special application to geography, adaptations to climate, uses for food, clothing, building, etc. As far as possible use the laboratory plan, observation from a series of written questions, pupils making their record and sketches to be written in a careful description after discussion. Direct pupils in forming sentences, aim to secure accuracy of statement, variety in form, choice of words. Regular drawing exercises on the plant forms, especially shapes of leaves. Geographical reading should supplement the observation for the specific purpose of broadening the view, followed by reproduction exercises. Also make appropriate literary selections for reading and memorizing.

Outline. Study of non-woody plants, woody plants.

September. Examine different kinds of fruit according to an outline—stone fruits, *e. g.*, peach and plum; fleshy fruits, *e. g.*, apple, grape; dry fruits, *e. g.*, acorn, chestnut, pods, grains. 1. Peach—stem, skin, pulp, stone, seed—position, qualities, use to the seed, way in which fruit changes for the escape of the seed. Sketch a vertical section with names of parts affixed, describe. Make a list of other stone fruits. 2. Apple—stem, blow, skin, pulp, core, seeds—same plan as above, draw cross and vertical sections with names, compare with stone fruit. Make lists of fleshy fruits. 3. Acorn—stem, cup, shell, kernel—same points as above, collect and compare other dry fruits with acorn, describe for busy work. 4. Collect grains in bottles, distinguish and name, notice that the seed vessel

clings to the seed, uses to man and beast. Silent and oral reading about foreign fruits. (Normal Fourth Reader, selections from "Child's Book of Nature."

October. Observation of a few typical deciduous trees. Teach to recognize the common shade and forest trees, mount and press leaves, bark, stems, and fruit of as many as possible for a class collection. Study one of each kind and compare, *e. g.*, maple and ash,, elm and oak.

Whole tree { where it grows best, adaptation.
general shape, size, foliage.
why cultivated.

Roots—tap-root, length and number of branches, adaptation.

Trunk { color and surface of the bark.
branching, high or low, angle, number of small branches.
growth of branch for the season, how shown, compare.

Leaves { position, size, arrangement.
veining, shape, simple or compound.
peculiarities, adaptation to the tree.
autumn changes, the meaning.

Fruit { (if in season) kind, position, coverings of seed.
means of dispersion, use to man.

Wood { make sections, rings of growth.
how wood grows from year to year.
compare section with corn stalk or banana stem.
characteristics of the wood and uses.

Compare the principal kinds of each tree so as to recognize by the differences, *e. g.*, white and silver maples and ash. Reading of historical trees, other appropriate literary selections. Geographical information about the trees in hot and cold climates, useful woods. (A Year with the trees.)

November. Similar study of evergreen trees, recognize and collect, study and compare two, *e. g.*, pine and spruce, pine and hemlock. Compare evergeen and deciduous trees as to time of shedding leaves and the adaptation, geographical distribution with maps. (Apgar's Trees of Northern United States.)

Language. Many short written exercises and oral descriptions of the facts observed and thoughts derived. Draw leaves and describe. Mount specimens. Use this work for material for spelling and language. Let the regular language work take this form. Use topical series of questions for written work.

Sixth Year.

Outline. Leaf outlines and frame work. Buds.

September. Continue study of trees and wild flowers, study of plants, parts useful for food, *e. g.*, grains, nuts, stems and roots. Foreign products—collect, distinguish, prominent qualities, means of distribution.

October. Parts of plants useful for fibres; cotton, flax and hemp. Geographical distribution of useful trees. Continue study of trees and wild flowers.

November. Continue work of fifth grade in evergreen trees. Make many comparisons. Reading of selections bearing on the subject.

Language. Many short written and oral descriptions, according to topical outline. Let regular language work take this form and teach in connection whatever comes in regular language course.

Seventh Year.

Outline. Structure of toadstools, puff-balls, lichens, stems, roots.

September. Study of plant products; properties and uses of starch, oils, gums and resins, spices, useful woods.

October and November. Simple study of lower forms of plant life, their characteristics compared with higher plants, and their functions in nature.

Language. Many oral and written descriptions, using topical outline if found necessary; otherwise, have pupils make their own outline.

Use this material for spelling and language work, making the regular work take this form. Sketch and mount.

Eighth Year.

Outline. Structure of flowers, structure of fruits and seeds.

September. Review of the study of plants. Essential parts of plants. Process of growth.

October. Prominent and useful families of plants studied. Drawing of whole plants. Topical outline.

November. Review of the study of trees. Comparison.

Language. Continue work of preceding grades. Use this material for the spelling and language work, and make the regular work take this form.

II MINERALS.

(WINTER.)

Primary Grades. The purpose of these lessons is to lead the children to find by observation the qualities of a few common substances, to apply this knowledge to a large number of objects, to think of the simplest uses dependent on these qualities, to express the facts in good oral and written sentences.

First and Second Years.

Children collect specimens of quartz, mica, coal, glass, chalk, marble, iron, lead, tin, etc. Sort in large boxes with labels, from which individual specimens may be selected for class use. Lead them to find qualities similar to the following: *quartz*—white or gray, shines, (glassy), rough faces, sharp points, does not bend, breaks, can rub off grains, cannot scratch with a nail, hard, found in rocks; *mica*—(compare with quartz) shines, can pick off leaves, smooth faces, sharp edges, soft when scratched with a nail, scratched by quartz, cut with scissors, leaf bends and flies back, see things through a leaf, used in stove doors, doesn't burn or crack; *coal* (hard and soft —black, shines, crumbles into small pieces, smooth faces, curved faces, sharp points, hard and soft, cannot see through it, used in fires, burned in engines, yellow and blue flame, black smoke; *chalk* —white, grains rub off, grains stick to things, breaks easily, soft when scratched, think of uses; *marble*—(compare with chalk), colors, breaks, made of grains, grains shine (crystals), can be cut and polished, uses; *glass*—(compare with mica), shines, smooth faces, sharp edges, breaks easily, hard, not bend much, see through it (transparent), made by man, think of uses and properties which make it useful; *iron* wire, plate—bend, dark color, smooth, hard, will not burn, uses; *lead*—soft, bends, dark color, shines when cut, smooth, melts, uses; *tin*—shines, white, bends, uses. (Compare the metals continually.)

Language. Apply these qualities as found to a great variety of common objects, use good oral sentences. Copy the names beside the objects, use the words in the sentences to be copied and read, sketch the rough outline with the simple sentences.

Third Year.

Review the qualities of the previous year, and observation of some of the rocks of the locality, collect and sort variety in boxes, also cut and polish pieces, *e. g.*, *granite*—made of pieces of quartz,

feldspar, and mica, shining pieces of crystals, hard, brittle, colors, opaque, can be cut and polished, places where used, apply the new ideas; *puddingstone*—begin with the story of pebbles in gravel from stream or beach, rounded stones, different shapes, rolled and rubbed together by water, puddingstone made of pebbles, rub off sand between them, pebbles and sand stuck together, pebbles hard, sand hard or soft, brittle, colors, opaque, places where used; *sandstone*—begin with the story of grains of sand from side of stream or beach, small shiny grains (quartz), sharp corners, rolled and rubbed together by water—scratch the rock, sand comes off, also finer pieces and powder like clay, all stuck together—find hard and soft sandstones, brittle, colors, places where used, compare with puddingstone; *slate*—begin with clay, very fine particles, notice odor when moist, sticky when wet, where found in town, uses—scratch slate, soft, fine particles come off, clay odor, compact, smooth, mark on it, colors, where used, compare with sandstone. (See Geology, Science Primers).

Language. Apply all the new ideas, make sentences using the words, teacher write new words on the board, use the sentences in the regular language drill, sketches showing outline and parts in connection with the written work.

Fourth Year.

Begin the observation of the common building stones of the town, *e. g.*, *granite*—collect specimens, note where found (ledges, boulders, gravel hills, buildings), of what made (glassy quartz, whitish feldspar, shiny leaves of brown or black mica), how held together (stuck together, soft, by heat and moisture, melted together), qualities which make it useful (hard, wears well, can be cut and polished, plenty, etc.), compare the varieties found (fine, coarse, reddish, greenish, dark with hornblende in place of mica), written description by questions. *Sandstone*—collect, where found, of what made (grains of sand mostly quartz), finer grains (rock flour), and powder (clay) between and around the grains, how held together (clay sticks the grains together, a cement), qualities which make it useful (soft enough to cut, hard quartz grains), compare the varieties (red-brownstone, gray, hard white sandstone), written description. *Slate*—collect, where found or used, of what made (fine particles of rock flour, finest particles of clay), how held together (clay sticks the rock-flour together into a smooth, soft rock), qualities which make it useful (soft, wears well, cut into shape easily, mark on it, etc.) Note colors of the varieties; written description. *Marble*—collect, where used, made of grains that shine (crystals) stuck together, soft, brittle, dissolves in water with acid in it, uses, (cut, polished, injury to polished surfaces by acid substances), note different colors, written description.

Language. Have many short written exercises and let regular language take this form. Use this work for spelling.

Fifth Year.

Observation of individual minerals and metals, arrange facts, apply new terms, written descriptions according to a series of questions, *e. g.*, *quartz*—collect different forms (in granite, veins, lumps, crystals, grains), of what made (rub off grains, compact), how hard (not scratch with a nail, scratch glass, therefore very hard), brittle, colors, shines like glass, see light through edges or more (translucent), doesn't change in the air, qualities which make it useful in granite, sandpaper, gems, mortar, etc. *Mica*—collect, made of thin leaves which bend (flexible) and fly back (elastic), sharp edges, plane faces, soft, easily cut, shines, colors, transparent leaves, compare with quartz, collect specimens showing decay of mica in rocks, qualities which make it useful in stove doors, granite, ornaments, etc., mount different colors. *Feldspar*—collect granite showing crystals, also individual pieces, rub off grains, hard to scratch with a nail, scratched by quartz, brittle, breaks with some plane faces, colors, shines not as much as quartz or mica, opaque, find decaying pieces with clay odor, think of qualities which make it useful in granite, in soil. Each pupil have a box for labeled specimens.

Metals. Collect and distinguish different forms. distinguishing properties, compare forms, think of qualities that make them useful, simple descriptions, mount specimens of metals, ores, useful products with labels, *e. g.*, *iron*—wire bends easily (flexible), uses; sheet iron in plates flexible, uses; cast iron, not bend, brittle, very hard, uses; steel, not flexible, elastic, very hard, uses; all attracted by a magnet; hold end of each in flame of alcohol lamp, all carry heat from flame to the hand (think how it is done), uses; all rust in moist air, how prevent. *Copper*—red color; wire bends more easily than iron, tougher than iron; gets warm in flame sooner than iron, uses; plate, scratched by iron, flexible, dull color in air, uses. *Lead*—gray color, very heavy, plate called sheet lead, can be flattened easily, soft, bends very easily, breaks by bending, fresh surface bright, melts easily (in a spoon), uses. *Tin*—silver white; foil thin, soft, bends easily; plate is iron coated with tin (attracted by magnet), keeps bright in the air, uses. *Zinc*—gray; plate flexible, changes little in the air; galvanized iron, coating of zinc on iron (magnet), uses. *Quicksilver* or mercury—liquid metal, gray, runs in globules or spheres, very heavy, evaporates quickly when heated in a spoon, uses. Find properties common to the metals (heavy, bright lustre of fresh surface, flexible and able to be hammered out, carry heat), arrange them in order of hardness. *Coal* minerals—collect peat, soft coal, hard coal, graphite; compare their properties; *peat*—roots,

stems; mud stuck together, swampy soil (sketch), when dry burned; *soft coal*—layers, brittle, shiny black, crumbles, burns easily, yellow flame, much black smoke, uses; *hard coal*—not scratched by a nail, compact, brittle, curved faces, shines, needs kindling, blue flame, little smoke, uses; *graphite*—hard grains, shiny crystals, very brittle (friable), greasy feeling, will not burn, uses; teach them as a series, formed from vegetable material, use pictures of coal mines, and supplementary reading, indicate geographical localities on outline maps of United States or western states.

Language. Have many short written and oral descriptions. Use this written work for spelling.

Sixth Year.

Study additional minerals according to a plan (forms, structure, hardness, cleavage, tenacity, color, lustre, diaphaneity, other special properties, varieties, uses), *e. g.*, talc and soapstone, gypsum and plaster of paris, calcite and marble, asbestus, etc. Compare constantly as studied.

Observation of the rock ledges in town. Conduct or send pupils to some ledge of rock, collect specimens for class study. Observe cracks in the ledge, in which directions they extend, effects of water running down or ice freezing, of growing roots, of water washing underneath (result, angular fragments break off and roll down), record observations and conclusions, sketch on a map of the town or section. In the class study the specimens, kind of rock, of what made, how held together, uses in town, (see fourth year), record observations as found, later oral and written description of ledge. Observe the bowlders,* where most common in town (map), compare shape with previous fragments, think how derived; determine the kind of rock, study as in fourth year, compare with ledges in town; record the work as directed, followed by a description of bowlders.

Observe a gravel hill, materials, how arranged, slopes, direction it extends (map,) sketch a section, record observations, collect specimens of gravel, sand, and clay; study the gravel, shapes of pebbles, kinds of rock grouped, think of the action by which they were rounded and arranged (stream or gutter in rain), record; observe the sand, grains, some crystalline, angular, mostly quartz, finest grains (rock-flour,) think of action in forming sand, and uses, record observations at time; observe clay, find two sizes of particles (rock-flour and clay), rub between hands (rock-flour gritty, clay soft), moisten, record observations, teach the relation of sand and clay to springs and wells, sketch; observe and indicate on the map the relation of

*This work will have to be done from descriptions and pictures almost altogether.

ledges, gravel hill, and clay beds to rivers (flowing around, cutting away, clay beds in valley), to railroads (avoid ledges, around or cutting through hills), to industries (quarries, stone crusher, roads and sidewalks, bricks, etc.) Written description of gravel hills and clay beds by an outline. Encourage collection of great variety of minerals, sort, name, observations of distinguishing properties, use in geography collections.

Language. Have many short written exercises and use these for regular language work and spelling.

Seventh Year.

Study of Ores, etc. 1. Iron ores, limonite, hematite, magnetite, pyrite. Observe properties according to plan (sixth year), compare the series, use magnet, compare with iron, locate on map, supplementary reading, written record. 2. Lead ore—study in same order, compare with lead, locate on map. 3. Marble or limestone (carbonate of lime), observe its properties, heat a lump in stove, observe change in structure (quicklime), add water (slaked lime), uses; effect of acids, carbonic acid gas. Test other substances, shells, coral, bones. etc., (written work).

Formation of soil from rocks. 1. Collect and observe sound rocks, name, distinguish minerals, find their distinguishing qualities (structure, hardness, plane faces, tenacity, colors, lustre, transparency), write descriptions. 2. Collect decomposing rocks, names, group them in boxes according to amount of decay, begin with weathering surfaces, which minerals change, in what ways, use points above; cracking rocks, kinds, parts cracking, change in properties; crumbling rocks, kinds, minerals which crumble, change in properties, product. 3. Soils of different kinds—(loam, subsoil, gravel, sand, clay), where occur (sketch section), of what composed, relation to rocks, use to vegetation and man. Written description of formation of soil by outline, use in connection with geography lessons.

Language. See previous grades.

Eighth Year.

A general study of earth building and of the different geological ages, avoiding technicalities and details. Use topical outline. Study briefly and without technicality sedimentary, organic and igneous rocks. The crust of the earth, the first continent, age of crabs and corals, age of pines and reptiles, the palm and man, vanished fauna, a mountain of fossils, written in the rocks, footprints in the sand, the winter of the world, the first crustaceans, stone fish and stone lilies, buried reptiles, birds of other days, early mammals, and other topics. (See Seaside and Wayside No. 4.)

Use collections of specimens already made to illustrate this work.

Language. Have many short written exercises on subjects connected with this work, paying attention always to neat penmanship. correct use of English, and a good style of composition.

III PLANTS.

EARLY SPRING.

Growth of Trees.

Interest the children in observing the bare trees, noticing the general shape, kind of trunk, plan of branching, number and arrangement of smaller branches. Think what it is that gives the peculiar shape and appearance to the tree, encourage sketching the general outline of the tree. Compare the trees in these points sufficiently to recognize the common trees.

Twigs. Select from this list—willow, lilac, elm, apple, cherry, cottonwood, ash, box elder. Children collect the twigs of different trees, directing them so no injury to property will be done. Study one carefully, *e. g.*, elm.

Branches. Color, size, surface (rough or smooth), arrangement, much or little spray, upright or drooping position. *Buds*—position (on tip, side, or both), form, size, color, number on a branch, buds lacking at places, covering, most prominent buds (terminal or axillary), think of the effect on growth of the tree. *Scars*—position (reference to buds), shape, arrangement (compare with buds), leaf-scars, where, dots; bud scale scars (rings), measure the growth of a season, count the years of growth, compare, think of reason for variation; flower scars (at the angle of branching) notice the effect on the branching; dots or cracks in the bark (escape of gases), where. Encourage sketching of whole and parts as the record is made. Place the twigs in water in sunny windows, also place part in shade to compare growth. Watch from day to day till ready for next stage of work, calling attention to the essentials for growth, warmth, sunlight, moisture, prepared food in the sap (how prepared).

Meantime study another by comparing with the first, now compare with buds on evergreen trees to note how whorls are formed. Encourage collecting a variety of twigs, observing out of doors, naming, and watching the unfolding. Selecting a few pupils to mount twigs, and wood, with name of tree and of parts affixed, leaving space if desired for leaves and other parts. *Outside observation is a test of interest.*

Opening buds. After the buds in the window begin to open

sufficiently, study the type as before, compare another with it, and encourage outside observation of a great variety of trees.

Scales. Pick them off with a pin and lay in order, count, color inside and outside, shape (sketch), how they covered the leaves inside, arrangement, how they resemble leaves, think of use in protecting leaves. *Sticky or wooly matter*—which, where, think of special use. *Opening*—spreading of scales (let in light, etc.,); unfolding leaves, how folded (why in that way); unfolding flowers, where, before or after leaves. *Growth* into branches, where are the strong buds, which do not develop, effect of growth of terminal and axillary buds on the shape and appearance of the tree. Select some pupils to mount a series of opening leaves from scale to full leaf to show relation of scales and leaves. Think of the plan of growth from year to year. Teach pupils to observe from a series of oral or written questions, sketching and making the record for themselves. Use another lesson for language drill, thinking of adaptation and information. Make a regular drawing lesson of the twig to accompany the final corrected written paper. Newell's Outline of Botany will help teachers in using this outline.

Suggestions. *Lowest Primary.* Collecting and keeping in window, conversational lessons with groups of children in finding different parts, thinking how they are protected, how they grow, and how they help the tree. Sketching for busy work. Originating short written sentences, teacher supplying new words. Reading the little sentences prepared, use of memory gems to interest.

Primary (2nd and 3d years). Collecting, oral questions and answers at first, as soon as possible children learn to write from questions as they observe. Teach sketching to accompany the final corrected papers. In these grades select material to call for the use of a wide range of descriptive words, to interest them in watching changes out of doors, to think of simple adaptations. Find reading selections to *follow* the observation, *e.* g., Normal Readers.

Intermediate (4th and 5th years). Collecting, written record with sketching from a series of written questions, to develop power to describe an object in natural order connecting sentences in a good description. Emphasize color, form, size, number, arrangement of parts and their adaptation, steps in growth, compare deciduous and evergreen trees, *Teach* sketching by showing the parts in their arrangement. Mounting and labeling. Final written paper to be used as a means of correcting faulty expressions. Newell's Botany Reader.

Grammar. Collecting, full descriptions written according to questions or headings, sketches of wholes and parts; drawings; em-

phasis on comparison and adaptation. Final paper for choice of words, well connected descriptions. Mounting and labeling comparative specimens. Evergreen and deciduous trees, adaptation to climate, geographical distribution illustrated by prepared maps of United States and Nebraska.

SPRING.

First Year.

Continue watching the growth of trees out of doors, opening leaves, flowers, and forming branches. Use in the morning talks. Continue collections in school room.

Outline. Herbs (5), Lichens (3), Mosses (2), Fern (1), Toad Stool (1).

Growth of seeds. 1, Observe dry seeds and seeds placed in moist sawdust or sand for the parts and their uses—scar, skin, seed leaves, bud or leaves inside, *e. g.*, compare bean, pea and corn. 2. Observe seeds growing on a moist sponge in a tumbler, changes from day to day; things needed for the young plant to grow, warmth, water, air. Child give a simple narrative of how the plant grows, with sketches.

Wild flowers. Use plants in the schoolroom early in the season. Children collect, point out and name the parts, mount on paper and write name of parts against them. Notice where it grows and how it grows, think of its adaptation to the place; observe qualities of each part, *e. g.*, position, color, form, surface of the stem, its use to the plant, stems used for food; color, form, surface and use of root to the plant, roots used for food; color of upper and under sides of leaves, shapes, uses, leaves used for food; color and odor of flowers, simple ideas of the parts and their use to the plant, watch and tell what insects do about the flowers.

Language. Conversational lessons with groups of children, originating short written sentences, teacher writing new words on the board as called for. Select reading lessons to fit the work, memory gems. Mounting and sketching for busy work. Teach spelling in connection.

Second Year.

Continue watching the growth of trees out of doors, opening leaves, flowers, and forming branches.

Outline. Trees (6), Herbs (7), Shrubs (5).

Wild flowers. 1. Similar to first year. 2. Special observation of leaves—to distinguish the parts, *e. g.*, petiole, blade, midrib, veins, stipules; form, color, arrangement of the parts, with adapta-

tion to beauty, shade, strength, getting air and sunlight for the plant; compare leaves in these parts.

Language. Lists of wild flowers on the board. Originate short sentences in answer to written questions, group into descriptions. Write of plants and insects they saw on the way to school. Press and mount wild flowers with names and names of parts, distinguishing points written beside them. Sketch single leaves beside the mounted ones, placing names of parts opposite each, sketch pairs or groups of leaves and write short sentences telling differences or resemblances. Teach spelling in connection.

Third Year.

Outline. Note the time when the leaves appear on various trees; when various flowers appear; when various little plants grow from the seed.

Growth of seeds (April.) First and second steps similar to first year. 3. Window gardens, observation of seeds planted in a box or in pots of soil (covered with glass to hasten growth,) *e. g.*, corn, pea, bean, morning glory, flax, canary seeds, etc. Note time and manner of appearance. describe changes in individual plants at different periods during the spring. Compare the plants at specified times and write comparative descriptions, watch similar growth out of doors, have a part of the school garden for this purpose cared for by the children.

Wild flowers and trees. (April-June.) 1. Note on the board or in a little field book the time when the leaves appear on the various trees, when the flowers appear, when various wild flowers are found and where they grow, think of adaptation. 2. (May.) Continue work of second year with *leaves*, observing less simple differences, adding new names as desired, position on the stem; upper and under surface; special form of base, apex, and margin; veining, relation to mid-rib, net-work or parallel; leaflets, position, number, form, relative size; think of adaptation to beauty, strength, shade, getting air and sunlight. Examples—plants in school room, apple, maple, grass, rose, horse-chestnut. Useful leaves, *e. g.*, lettuce, dandelion, Indian corn, etc. 3. (May-June.) Apply the knowledge of leaves to a few of the common wild flowers, general observation of all the parts of the plant, mounting, writing simple descriptions containing the distinguishing features of the parts, especially of leaves. Examples —buttercup, cherry, wild oats, violets.

Language. Lists as before; sentences describing prominent and distinguishing qualities grouped into descriptions. Sketch single leaves and groups of leaves, with descriptive words accompanying,

color if desired. Mount sets of leaves of a kind with names, also sets showing a gradation from simplest to compound. Select stories about leaves for reading lessons. Teach spelling in connection.

Fourth Year.

Outline. Where are particular herbs found?

Observation of flowers. 1. (April-May.) Watch the opening flower buds on the different trees, *e. g.*, elm, maple, cherry, apple, lilac, etc., etc. Note the time of appearance in a little field book or on the board. Mount and write a simple description, noting size, color, position on the branch, kind of cluster, stem of each flower, opening of the flowers in each cluster. 2. Teach with care the parts of a flower from some quite regular, complete flower, *e. g.*, geranium, cherry or apple. (Do not use the technical terms with the children.) Corolla, calyx, stamens, pistil; petals and sepals; stalk and pollen of stamen, stalk and seed vessel of pistil. Watch and report the manner of changing into fruit. 3. *Wild flowers* (May-June.) Collect and name, mounting outside of school hours, note the time and place of finding. Apply the study of flowers to these, noticing size, color, form, number, and arrangement of the parts; compare pairs of flowers. Examples—anemone, wild rose, wild strawberry, buffalo pea, wild plum, wild oats, violet. Teach ideas (not the names) of symmetry, regularity, completeness, perfectness, 3-4-5 parted flowers. Interest them in watching the habits of flowers in the school room, in the school garden, and at home, in the time of flowering, duration, falling off of parts, sleep, turning toward the light, etc. Lead them to think of the uses of flowers, *e. g.*, those which develop into fruit used for food, honey, beauty, odor. Also watch the insects about the flowers—bees, butterflies, beetles, etc., how they get the honey, and simple idea of their carrying pollen from one flower to another. Observe the parts of the bee and butterfly alive under glass, and then liberate.

Language. Lists as before, sentences describing distinguishing qualities in answer to oral or written questions, grouping into descriptions, especial care in comparative descriptions. Sketch the parts of a flower arranged in circles with names attached, color if desired, also the position of larger flowers in clusters, direct this carefully at first, then use it as busy work. Select reading lessons to fit this work and increase the interest, memorize a few appropriate poems on flowers, teach spelling in connection with written exercises. Newell's Lessons, Part II. Normal Readers.

Fifth Year.

Outline. Study of herbs, mosses, lichens.

Systematic observation of typical shrubs and trees. 1. Distinguish herb, shrub, and tree. Use many illustrations, apply to vines, written paper. 2. Observation lessons to distinguish the marks of a stem, (different specimens may be used)—teach to find node, internode, and leaf growing at the node, compare with the root, draw with names attached. 3. Conversational lessons on the positions of stems in growing, advantage of each, special kinds and uses, *e. g.*, raspberry suckers, strawberry runners, grape tendrils, thorns, etc.; illustrate by sketches of specimens, pupils reproduce (not copy), written paper from headings. 4. Observation lesson on the structure of stems. Collect stems of different trees cut crosswise and lengthwise, young twig, older wood, and a still older branch, distinguish and name (apple or elder are especially good). Observe the parts in the cross section—soft bark outside, hard ring of wood, soft pith in the centre; compare with older stem, bark, rings of wood, pith; then compare with the oldest in the same points. Apply to any lengthwise section, find fibres of wood. Sketch a section with names of parts attached. Observe where in a stem the sap is found, hence where the growth is, explain simply how it grows. Why does the bark crack? Written paper corrected to apply language lessons. (5)· Compare these stems with stems of banana, hard on outside, softer pith inside, hard fibres running through the pith lengthwise of the stem. Sketch a section of banana stem with names attached. Written comparison. Encourage individual pupils to prepare and mount sections of wood with leaves, etc., also mount and label specimens of bark. (6). Conversational lessons on useful kinds of bark, *e. g.*, flax, hemp, cork, hemlock, etc.; useful stems, for food, willow, sugar-cane, etc., apply in the geography lessons. (7) Teach to describe a leaf according to a simple plan—arrangement on the stem; blade—simple or compound, feather or palmately veined, shape of apex and base, kind of margin, surface; petiole, long or short, hairy or smooth; stipules, present or falling off. Mount a leaf, sketch it, write a description beside it. (8) Teach to describe a tree or shrub according to a plan, size, form, branching; kind of trunk, color and markings of the bark; leaves—kind, arrangement, shape, any peculiarity; flowers, single or in clusters, color, peculiarity; fruit, when formed, kind; kind of wood. Written papers with sketches interpersed.

Careful drawing of simple leaves in regular lessons.

Language. Oral and written descriptions of plants. Let regular language work take this form. Teach spelling in connection,

Sixth Year.

Outline. Leaf margins and compound leaves.

(1) Preliminary lessons on the parts of a plant, using any convenient illustration. Root—long fibres, tapering rootlets, hairs. uses to the plant. Stem—shape, color, surface, joints, uses to the plant. Leaves—shape, color, surface, parts, arrangement on the stem, uses to the plant. Flowers—position, parts, use of each, formation of fruit and seeds. Written description, sketch of some plant with names attached. 2. Systematic observation of a few typical wild plants or house plants, taking all the parts in order, according to a simple outline, as a laboratory exercise.

(1) Where it grows, how long it lives, height.
(2) Root—kind.
(3) Stem—position. surface.
(4) Leaves—arrangement, kind, form, margin, surface.
(5) Flowers—arrangement, size, parts.
(6) Fruit—kind, form.

Examples—Violet, anemone, wild plum, wild strawberry, buffalo pea, wild rose, plants of school garden. Encourage collecting and naming as great a variety as possible of wild flowers of each month; mounting the dry plants with names; written descriptions of a few corrected to apply regular language work, with sketches interpersed. *Careful drawing of compound leaves and flowers.* Memory gems appropriate to the plant studied. Newell's Outlines of Botany, Part II, is especially helpful to teachers.

Language Work. Oral and written descriptions of plants. Have them short, but plenty of them. Let regular language work take this form. Teach spelling in connection.

Seventh Year.

Outline—Structure of flowers.

1. (April). If necessary take the preliminary lessons as in sixth year. Write a careful description of some house plant, *e. g.*, geranium, from an outline of points (Newell's Outlines, Part II, p. 284.) Sketch the different parts as described. 2. Encourage the pupils in collecting all the different plant forms for a school collection, keeping in shallow boxes or mounting with common name and place where they grow, *e. g.*, lichens, mosses, ferns, grasses, and wild flowers as they appear. In mounting, group those on a sheet which flower at the same time, arrange the sheets by dates. 3. (April-May) Systematic comparison of trees, *e. g.*, compare elm and maple—stem, branching; leaves, arrangement, kind, shape, petiole, stipules; flowers, time, color, position, arrangement, parts present and their

number; fruit, kind, shape. Write out a comparative description. In what are they alike? (deciduous trees, woody stem, flowering, fruit a key); differ in their parts. Think of the opposite of each characteristic, evergreens, soft stems with fibres of wood (banana, palms, asparagus), flowerless plants (consult the collection), trees with fleshy and stone fruits. Make lists of each group. Apply to the geography in location and adaptation. 4. (May-June). Comparison of wild flowers and trees of same family, *e. g.*, cherry, plum, apple, rose, blackberry, raspberry, strawberry. Each pupil write out his own description, then compare and find that they agree in alternate leaves with stipules; regular flowers; sepals five, united; petals five, distinct, on a disk inside the calyx tube; stamens many, distinct. Hence belong to the same family—Rose family. Write description of one of the following: red bud, peas, beans, wild vetch, ground plum, clover (white and red), (leaves net veined, flowers irregular, &c., stamens 10, pistils 1, a pod), then compare others with it for resemblances and differences; determine the chief marks of the bean family. Do not give the technical part to children.

In similar manner, compare orchard grass, "spring lilies," the iris and lily of the valley. Encourage sketching all that can be done in connection with the descriptions. The regular drawing should include sprays of the plants studied.

Language Work. Oral and written descriptions; make them plenty, but short. Let regular language work take this orm. Teach spelling in connection.

Eighth Year.

Outline. Growth of seeds and structure of seedlings.

Continue the work of the seventh year or 1. Collect the different plant forms, distinguish the essentials as follows—plant body and fruit of the larger fungi; stalk, cap and gills of toadstools; root, stem, leaves, hairs, spore dots of ferns; root, stem, leaves, hairs, flower and seeds of flowering plants. Note the place of growth of each and adaptation to climate, hence the charateristic vegetation of different latitudes. Written descriptions of plant forms which bring out the gradations, with simple sketches. 2. Collect and mount a variety of common grasses and grains with names of locality. Observe distinguishing characteristics, stem—cylindrical, usually hollow, jointed; leaves—simple, alternate, parallel veined, slighty hairy, sheathes split open; flowers in spikelets, with bracts at the base of each flower; fruit—grain rich in albumen, used as food for man and beast. Specially useful members of this family—grains, sugar cane, bamboo, etc. Get foreign specimens if possible to apply in geography. Written papers with sketches. Useful families of plants—school

collection of parts of plants used for food, clothing, medicine, spices, dyes, economic purposes (palm), useful and ornamental woods, cultivated trees, shrubs, flowering plants and vines, etc. Individual pupils investigate, write descriptions, prepare maps, apply to geography. This to serve as a review of plant work. "Ricks' Natural History Lessons."

Use outline map of United States and the county outline map of Nebraska to show by shading the distribution of plants.

Language. Have many short oral and written descriptions of plants. Make the regular language work take this form. Teach spelling in connection.

III ANIMALS.

(I) ELEMENTARY LESSSONS ON COMMON ANIMALS.

The *aim* of these lessons is (1) to interest the little children in the animals about them, (2) to lead them to observe the habits and distinguishing marks, (3) to teach them to describe what they see in oral form and in simple written sentences, (the observations may serve as the basis of language work,) (4) to lead them to think about the uses, adaptability of parts to the life, and the need of kindness to to the animals.

First Year.

Conversational lessons on pet animals, domestic animals, birds about the school, common insects, other familiar animals. *Observation*—recognize and name new animals, single qualities of the animal and its parts, habits and voices (homes, ways of eating, drinking, flying, building nests, care of young, etc.). Begin collections, *stuffed birds*, insects, cocoons, shells. *Language*—at first oral; to read and copy names of animals and their parts, short sentences describing qualities and habits; simple narrative stories from pictures.

Second Year.

Observation—domestic animals, distinguishing parts and qualities, habits, uses resulting; birds, recognize and name as they come in the spring, watch habits, and single distinguishing qualities; insects, recognize and name, places where found, single qualities and habits; other animals of the locality. Continue collections, mount insects. *Language and drawing*—same as first year, group sentences into short descriptions and stories, draw insects, supplementary reading to interest them in animals like those observed, stories to inculcate kindness. [Johonnot, J. G. Wood, Wright's "Seaside and Wayside."]

Illustrations. *Cat*—fur, teeth. tongue, whiskers, eyes, power of smell, paws and stealthy action, claws and climbing, voices with meaning. Uses of each. *Dog*—hair, teeth, tongue, power of smell, paws and claws (differ from cat), voices, stories of intelligence. *Horse*—covering, mane, teeth, position of ears to show feeling, hoofs, voices. "Black Beauty." *Cow* or *Ox*—covering, teeth and chewing the cud, hoofs, voices, uses to man. *Squirrel*—colors. covering and tail, teeth, claws, getting and storing food, agility.

Birds—teach children to watch them and recognize those seen by their colors, habits or voices; recognize stuffed specimens by colors, appearance, and peculiar parts. Use pictures to aid. *Illustrate.* The robin-redbreast, running and hopping on the ground, getting worms, nests in trees, sings in morning and during day. comes early in the spring, young robbins learning to fly. The woodpecker—color, nests, climbing and tapping trees, bill and toes. The humming bird—very small, colors, flying around flowers, long beak. Hawk or Owl—size, color. eyes, bill, claws, stories of habits. Duck—swims, getting food, toes, bill.

Insects. Examine live insects in bottles, teach to distinguish and give special names, e. g., beetle, cricket, butterfly, moth, bugs; teach to watch the positions and movements, *e. g.*, butterfly resting with upright wings, the moth with wings down, the fly crawling over the glass and how he does it, the grasshopper with long hind legs ready to jump, the beetles running around; teach to observe some of the prominent parts, *e. g.*, the hard brown wings of the beetle, the six legs with rough sides for digging, the black or brown eyes, the jaws for biting, and the moving feelers; the dragon fly with its four large, thin wings which he moves up and down, the many veins in the wings, the large eyes, their lips and jaws, the long body.

Collect with a net *water insects* keep them in a jar of water with some plants, observe them swim, come to the surface to breathe, eat and rest. Collect caterpillars, observe them eat, crawl, spin cocoons, keep the latter in boxes till they come out. Interest the children in outdoor observation, where they see different insects, what doing, of what use. *Language and Drawing*—same as first year, group sentences into short descriptions and stories, draw insects, supplementary reading to interest them in animals like those observed, stories to inculcate kindness. (Johonnot, J. G. Woods, Wright's "Seaside and Wayside," Normal Readers.)

Third Year.

Compare common *vertebrate* animals for differences and resemblances.

Horse and Cow.

Differences between horse and cow. Compare in size, head, ears, teeth, neck, shape of trunk, length of legs, hoofs, and ways of walking, length and smoothness of hair, differences in motions, voices and meaning of each, noticeable habits, uses to man. *Resemblances.* Covering, teeth for eating grass, hoofs. Similar lessons on Cat and Dog, Rick's I and VIII, Cow and Sheep, XVII. Write these differences in sentences, combine into short descriptions, placing emphasis on use of comparatives.

Differences in the Habits of Animals.

(Based on actual observation of animals, accompanied by conversations, followed by written language work.)

In position.

The *man* grows and walks erect.
The *cat* stands and walks in a horizontal position.
The *crow* flies in a horizontal position, stands in an inclined position.
The *frog* sits in an inclined position.
The *snake* lies on the ground.
The *oyster* lies in one place on the ground.

In locality.

The *fish* lives *in* the water, how?
The *whale* lives *on* the water, how?
The *frog* lives in the water and on the land, when? how?
The *earthworm* lives in the ground, use?
The *quail* lives on the ground, where?
The *robin* lives in the air and on the trees.
The *crow* lives in one place all the year.
The *bluebird* goes to a warmer country in the winter.

In locomotion.

The *fish* swims in the water with his fins and tail.
The *goose* swims in the water with his web feet.
The *dog* swims in the water with his legs.
The *robin* flies in the air with his wings and tail.
The *bat* flies in the air with his long webbed fingers.
The *leech* has a sucker at each end by which it draws itself along.
The *earthworm* draws itself along by little spines pointing backward.
The *snake* glides along by scales on its lower side and by curving the body.
The *fly* walks on the ceiling by using a sticky substance on its foot.
The *turtle* crawls with its short legs.
The *horse* walks on its hoofs.
The *cat* walks on its toes.
The man walks on the sole of his foot touching the ground with his heel.

In getting their food. Prepare lessons similar to the above.

In eating and drinking. Consult *Orton*, chaps. VII, XIX.

In mating, in their homes, in multiplying.

Birds—continue recognizing and naming new birds, parts of a bird in order (stuffed specimen), see Illustrative lesson; also lesson on feathers, Ricks' IX and X, on an egg, IV. *Insects*—begin with live insects, parts, qualities, and habits, see illustrative exercise.

Language and Drawing—lists of new animals, drawings with names of parts attached, coloring, descriptions, comparisons grouped, anecdotes read and written.

Fourth Year.

Group common *vertabrate animals* according to resemblances. (1) From list of animals let pupils select and arrange according to their covering, hair or fur, feathers, scales, smooth skin; warm or cold blooded; breathe air with lungs or air from the water by gills; swim or fly; etc. (2) Make lists of animals that are flesh eaters (carnivorous); grass eaters (herbivorous); gnawers (rodents); chew the cud (ruminants); describe the characteristic parts. (3) Make lists of those having two or more essential qualities the same, carnivorous birds; swimming birds, flying quadrupeds. "Ricks" ' XXIV–VI. Group *birds* into swimmers, scratchers, etc. Examine a duck, the bill and its use, feet and toes, shape of the body, make a list of birds like the duck, read "Wright, 3" XXIX. Study and read of other birds in the same manner. Observe *fishes* in a tank of water, their movements, breathing, eating, shape of the body, scales, fins and tail, eyes and gill covers; read "Wright, No. 3," XL, etc. In the spring observe tadpoles, frogs, and turtles in same way. Continue observation of *insects* followed by reading from "Wright."

TURTLE.

Specimens. Have a live turtle in a jar of water, with a board or stone so that he can get his head above water. Have old shells of turtles, and a preserved specimen. (Spring).

Covering. How is a turtle protected? watch him, how does he protect himself? what is the shape of upper side of the shell? under side? colors of each side? how does the shell feel? border of shell, smooth or notched? count number of pieces on upper shell? shape? thick or thin? what is the rest of the shell?

Head. Shape? large or small? watch him, what can he do with his head? why? shape of the *snout?* large or small *eyes?* color? how many eyelids? where is the *nose?* nostrils close together or far apart? size of *mouth?* teeth? with what are the jaws covered? shape at the end? why? shape of the tongue? how does he use it?

Neck. Long or short? observe the skin around it?

Trunk. Where highest?

Limbs. Count claws on front feet? on hind feet? look between the toes of the feet, what? why?

Voice. Has he any? how does he use it? when do you hear it?

Habits. Where do they live? what eat? how breathe?

FROG.

Specimens. A live frog in a jar of water. In the spring, eggs and tadpoles in water.

Covering. With what covered? general color? color of spots? of under side? how does surface feel?

Head. Shape? large or small? can he move it? size of *mouth?* rub finger along edge of jaw, feel? why? watch under side of the throat, what movement? why? shape of *tongue?* where attached? why? on which part of head are the eyes? prominence? color? eyelids? touch eye, change? where are the *nostrils?* what movement to the nostrils? find the ears, shape? color?

Trunk. Shape when sitting? when swimming? watch the sides, motion? why?

Limbs. Which legs the longer? toes on each foot? which are webbed? why?

Voice. Kind? how made? when do we hear it?

Habits. Where live? what are the young called? what eat? how breathe when young? when older?

Language. Write simple descriptions of the groups of animals, also of the new animals. Read about the habits, repeat or write the stories. Continue the drawing of insects.

Fifth and Sixth Years.

Continue each kind of work of the preceding grades applied to animals which are types of those of which pupils read in geography, *i. e.*, distinguishing marks, comparison and grouping, adaptability of parts to surroundings and habits to needs, special uses to man.

Observe.	*Reading.* (pictures).
Cat or dog	lion, tiger, leopard, etc.
Cow or sheep	buffalo, camel, deer, etc.
Squirrel or rabbit	beaver, prairie dog, etc.
Common birds	eagle, vulture, etc.
Turtle	tortoise, alligator, etc.
Common fish	food fishes, etc.

Useful and injurious insects, to recognize, and observe habits.

Language. Oral and written description of the distinguishing marks of the common animals; reading (with picture) of foreign animals, descriptions, stories of habits and uses. (Normal Readers, §III, Ricks', Johonnot, Nos. 3 and 4. J. G. Wood.)

Illustration. Cat—covered with fur, hairs point backward; backbone very flexible for springing; strong muscles; soft pads for feet, $\frac{5}{4}$ toes; sharp retractile claws, use? four long pointed teeth, uneven molars, use? tongue rough with horny points, use? whiskers,

use? changes in pupil of eye, use? Read, Normal Reader. Compare foreign animals of cat family. Similar lessons with the others.

Conversational lessons on the animals at home—dog, cat, horse, cow—to interest and stimulate observation, and to form a basis of language lessons.

Dog.

How many have a dog? his name? What kind of a dog is it? What color is he? How long hair has he? What can he do? Name the parts as I point to them.

Head. What kind of a snout has he? What does he do with it? How does the nose feel? How well can he smell? What kind of a mouth? How does the tongue feel? What does he do with it? What kind of teeth? Why? What kind of ears? How does he hold them at different times?

Neck. How long is it? How far can he turn it? Why?

Trunk. Where is it large? Where small? How use the tail? What does he show by it?

Legs. Which are the longer? How many toes has each? What kind of claws? How does he use them?

Voice. In what way does he use it? What does he mean by each?

Similar lessons on the horse, cat, or cow.

Bird.

How many of you have a bird at home? What kind is it? What color is it? What can it do? What is the name of this bird? (present a common or stuffed bird.) Where have you seen it? What is the color? With what is the bird covered? What parts are not covered with feathers? Why does he need feathers? Name the different parts as I point to them.

Head. What is the shape of it? feel of the bill, of what is it made? how many parts has it? What does he do with it? Why is it pointed? how does he eat? drink? find two little holes on the bill, what are they? What shape are they? how are they protected? Where are the eyes? What color are they? do they look fierce or gentle? Teacher find the ears, where are they? how are they covered?

Neck. How long is it? What does he do with it?

Trunk. Feel of it carefully, what shape is it? What kind of feathers on the breast? Where do the wings grow? Are they long or short? What kind of feathers on the wings and tail? how does he use them? how high can a bird fly? With what are the legs covered? how many toes in front? behind? What is on the end of the toes? What does he do with them?

Observe the birds seen around the school house and home, when do they come, where from, where do they build their nests, what do they eat. when do they go, and which stay over winter? What good do the birds do? Read stories that will lead the children to love the birds and protect them.

AN INSECT. HONEY BEE.

Ill. Dead bees, one for each pupil; live bees under a tumbler; honeycomb and honey; cell of queen bee if possible; pictures of bees and their hives.

What are these? Where have you seen them? What were they doing? (Draw out briefly the work of the bees in getting honey and polien from the flowers, storing it in the comb of wax which it makes.)

Body made of three parts which move on each other, name these parts, head, middle, and hind part, wings, legs.

Head—front part; two large eyes on front and side of head (eyes made of little parts to see on all sides); two short feelers between the eyes (to feel its way among the flowers and in the hive); mouth on the under side, jaws for biting, long curved tongue (to be folded in or thrust down into the flower for licking or sweeping in the honey.)

Middle Part—covered with hairs; four wings, two large and two small ones, in pairs, thin wings with veins in them (to stiffen the wings and help breathe); six legs, three on a side, in pairs, made of little parts, hairy, small sharp claws on the end (to climb about the hive and flowers), hind pair of legs flattened (to carry pollen).

Hind Part—made of rings, one partly over the other (between these wax is formed and squeezed out of the body); on the end is a sting (for killing other insects and protecting itself).

Habits—explain the growth (1) eggs laid by queen bee, (2) grub in the cell fed on beebread (honey and pollen) by the workers, (3) chrysalis shut up in cell, (4) bee-cell is of wax, six-sided, full of honey stored for the winter. Read some Nature Reader.

Kinds of Bees. Teach as many as you have specimens, *e. g.* Humble or "Bumble" bees, large, very hairy, yellow in some parts, builds nests on the ground under stones.

Insects like Bees. Wasps, not as hairy, build nests of wood ground into paper, and mud, in holes, on bushes, in crevices; hornets; ants.

Similar lessons may be given on other insects or the lower animals by simplifying the subsequent outlines.

(2) LESSONS ON THE EXTERNAL PARTS OF TYPICAL ANIMALS.

Sixth, Seventh and Eighth Years.

The *aim* of these lessons is training in (1) accurate and orderly observation, (2) concise expression, (3) careful comparison for differences and resemblances leading to grouping of animals, (4) simple generalizations.

The *order* of work is (1) examination of the specimen by a series of definite questions, at first oral then written, (2) expression of the facts orally, in writing, and by drawings, (3) arrangement of the facts in outline on the board, (4) reading concerning the habits, etc., (5) connected written description of the whole, (6) comparison with other animals.

Suggestions. This work may well be divided into two courses, (1) for the *sixth and seventh grades*, consisting of the observation and description of a few animals selected from the list given, with some drawing, a few comparisons and the simplest grouping. This course may include (a) starfish; sea urchin, the two compared, (b) earthworm (c) three or four bivalves observed and compared, (d) two or three univalve shells, (e) lobster and crab, (f) dragon fly, grasshopper, beetle, butterfly, moth, bee, observed and compared, their habits and life history, simple grouping of insects. (2) for the *eighth grade*, a fuller list with increased comparison and grouping, adding something of internal parts.

Illustrative Exercises.

Lesson on a Sponge.

Ill. Small commercial sponge for each pupil. Sponge in alcohol showing the sponge flesh in place.

As a Whole. What is its form? color? press it with the hand, then let it free, what do you observe? wet it and try the same.

Parts and their qualities. *Skeleton.* Of what material? pick it apart and examine with a magnifying glass, of what is it made? of what shape are they? how arranged? burn a few, what is the odor? what remains? *Pores.* What two kinds? where are each? look down into the largest ones, what becomes of them? cut down one of these and trace it by gently pushing a bent wire into the tubes, how far does it extend? hold the split tube to the light, how are the other tubes arranged? in what direction do they extend? in which directions do the very small pores extend? *Soft part.* Where are the soft parts seen? what relation do they bear to the pores? how do they look under the glass?

Lesson on Corals.

Ill. Masses of coral skeleton, single, cup corals.

Skeleton. What is the general color? touch with acid, what is the material? with what is the surface filled? how are the partitions (septa) arranged in the cups? examine the length and size of the partitions, what is the plan? how many partitions are there? where are they united? what is formed in the centre? how are the individual cups united? how is the season's growth indicated? (Draw.)

Animal. "Polyp." *Ill.* by anemone, by model and by drawings. What kind of a body has it? what is there about the mouth? how many? length? examine the drawing for the relative position of the stomach in the body cavity. Teacher explain the secretion of the coral skeleton by the animal, and the method of growth, (copy drawing of a section.)

Varieties of Corals. Examine each for its general shape, the form and arrangement of the cups, tubes or furrows. Examine some "Gorgons" or "sea fans," what is the character of the axis? Touch with acid and also burn a small bit, what results? what is the nature of the dried coating which covers the axis? with what is it pierced? what are the shapes of some of the varieties? From the model of the red coral, notice the arrangement of the fleshy part and the axis, the grooves on the surface, and the kind and number of tentacles. Compare these two groups (orders) of coral. Determine the common marks of a coral.

Read Orton. Hyatt, No. 5. Cooper. Pamphlets on Corals.

Blackboard Outline.

Skeleton. White—made of lime.
Surface filled with cups or tubes.
Cups have septa in multiples of 4 to 6.
Septa alternating long and short, united below.
Cups joined by a lime wall.

Animal.

Soft body, tentacles about the mouth.
Stomach in the centre of the body.
Septa lined with a membrane which secretes the lime.
Growth by buds.

Compare the Jellyfish and Coral.

Soft jelly-like body	Soft body around a lime skeleton.
Radiating tubes.	Radiating septa.
Long tentacles on lower side.	Shorter tentacles on upper side.
Hydroid development.	Growth by buds.

Blackboard Outline.

COMMERCIAL SPONGE.

Whole. form . . . . . bushlike.
color . . . . . yellowish, light or dark.
elastic when dry, when wet it swells.

Parts. 1. Skeleton.
made of fibres.
fine, long.
arranged in a net work.
horny, burning to ashes.

2. Pores.
Large pores.
branching till they become very fine.
used to carry *out* the water.

Smaller pores.
radiate from larger ones.
holes arranged in circles of growth.

Very small pores.
extending in all directions.
bring *in* water with food and air.

3. Soft Parts.
surround the hard parts.
line the pores.
the sponge animal.

Read such books as Hyatt's Sponges, Miss Cooper's Animals on Land and Sea, Mrs. Tenney's Pictures and Stories of Animals, for habits, uses, value, etc.

Write a connected account of the sponge, prefaced by a drawing made under the direction of the teacher.

Compare different sponges of which you may have specimens, in form; color; size; material; arrangement (singly, in clusters, or in colonies).

Lesson on Starfish.

Ill. A dried starfish for each, small broken pieces for each, (to dry starfish place in warm water 15 minutes, then in oven till dry), a specimen preserved in alcohol, if near the shore a live specimen in sea water.

Whole. What is its shape? color?

Parts. *Skeleton.* How many rays? from what do they extend?

their shape? length? scrape the outside carefully with a knife, with what is it covered? hold a broken piece to the light, how are the hard parts arranged? (draw). What small bodies on the outside? their shape? how are they arranged? try to move them. *Upper side* of skeleton, find a larger body, where is it? its shape? color? examine the top of it with the glass, with what is it covered? find a spot on tip of each ray, its shape? color (alive)? *Under side* of skeleton, examine the grooves on the rays, how far do they extend? where do they meet? look along a groove which has been cleaned, with what is it filled? look on an uncleaned portion, what extend out of these holes? how many rows of these tubes (feet)? on the inside of preserved specimen observe where these feet extend, how do they feel? Examine the mouth at the union of these grooves, what is its shape? how many pairs of spines surround it? pick into the mouth for the stomach, what does it seem to be?

Blackboard Outline.

Whole. Form . . . . starshaped.
Color . . . . brownish, reddish when alive.
Habitat . . . clings to stones and piles.

Parts. Skeleton as a whole.
five rays.
extending from a circular disc.
taper to a point.
sometimes vary in length.
covered with a very thin skin.
made of hard plates with spaces between.
dotted with many rounded bodies (tubercles).
arranged in rows.
immovable.
with little pincers scattered between them.
Upper side of the skeleton.
water (madreporic body).
large, rounded, covered with lines (like sieve).
between two rays.
eye spots.
on tip of each ray.
reddish in life.
Under side of the skeleton.
grooves.
extend length of ray.
full of small holes through which tube feet extend.
arranged in four rows.
soft and full of water.

mouth.
surrounded by 5 pair stiff spines.
stomach (thin bag) thrown out of it.

Habits. Read chapters in Miss Cooper, Mrs. Tenney, etc. Write a connected account of the starfish.

Lesson on Oyster Shell.

Ill. Matched oyster shells for each pupil. Burnt pieces of shell.

Surface. Pass the hand over the outside, how does it feel? how does the inside feel? What is the color of the outside? of the inside? On the narrow end find where the shell was attached to the rock. Examine the burnt pieces, of what kind of matter is the shell made?

Margin. Pass the hand around the edge of shell, how does it feel? of what color is it? what kind of a line is it?

Beak and lines of growth. Examine the narrow end of the shell, compare its thickness and shape with the other part of the shell. Examine the lines running around the beak and thence down the shell, how are they arranged? Where did the shell begin to grow? From which side were the layers put on?

Parts. How many parts? (valves) What is the difference in shape? Draw an outline of each valve, putting on the names of the parts. Carefully lift one valve on the other, what holds them together? (ligament). Push the valve down, what does it do as you let go? (elastic). Where is it? What is its color? What projection on the valve near it? (tooth) examine the other valve for teeth. Examine the inside for a large spot, where is it? What is its color? in which direction does it extend? Which way has the animal grown?

Examine other shell in a similar manner, e. g., clam, quohog, mussel scallop.

Lesson on the Mussel. (Fresh water clam). (upper grade).

Ill. Have the mussel cut open carefully, leaving the valves of the shell in place, with the beak *from* you.

Mantle. Rest the mussel in the one valve, remove the upper one, find a thin membrane next the lower shell, what is its color? what color is the edge of it? what kind of a line is the edge? Trace this mantle around the shell, how far does it extend? Find a similar membrane on the upper side of the body, what is the use of the mantle?

Muscle. Near the ends of the muscle, find the thick muscles; what is their form? of what use are they?

Liver, etc. Find a large brown mass, (liver) near which end of

the animal is it? Cut it open, find a tube running through it (stomach and intestine). At the upper right end find some soft lips, how many? in between the middle ones find a mouth. Just in front of the muscle find a cavity in which a transparent sac rests (heart), how many parts to it? of what size? Next to the mantle find some thin membranes (gills); how many pairs? how far do they extend? of what are they made?

Blackboard Outline.

THE MUSSEL.

Two Parts	shell or hard part	to protect the animal.
	soft animal inside	used for food sometimes.
Shell.	somewhat rough or wrinkled or smooth	grows on bottom of ponds and creeks.
	inside smooth and pearly	secretes pearl.
	mark of attachment near beak	used for lime.
	chalky when burnt	
	Margin nearly regular, edge soft and dark colored.	new growth of shell.
	Beak and lines of growth	
	thick and pointed end	shell grows from
	lines around the beak	the beak by layers
	parallel to margin of shell	on the inside.
	Valves—two, equal,	bivalve shell.
	hinged at beak end,	opens to take in
	open a short distance	the water for food, etc.
	Ligament.	
	at beak end	like a spring to
	dark brown, tough, elastic	hold shell open.
	Muscle scars.	
	near sides of valves	attachment for
	indistinct spots	muscle, moves as animal grows.
Soft Animal.		
	Mantle—thin leaves lining the shell	enclose body, makes
	edge thickened and darker	and repairs shell.
	Muscle—near anterior and posterior end of animal.	used to shut valves.
	Liver, etc.—brownish mass at upper end	digest the food
	contains a tube (stomach and	which is taken in

intestine), mouth opening between lips at upper end another opening on side of muscle	the water, currents made by little hairs (cilia) on the gills.
Heart—sac in a cavity just above the muscle, two parts blood-vessels run to and from it.	sends blood over the body.
Gills—Four leaflike membranes marked with parallel ridges	purify blood by use of oxygen in the water.

Uses. Animal for food, pearls inside certain mussels for ornament, shells are burnt for lime.

Animals like the Oyster.

SCALLOP.

Whole shell. Thin, circular shell, scalloped edges, furrows radiating from the beak, (draw).

Valves. Equal, long straight hinge, short ligament.

Animal. Mantle dotted with brilliant eye spots, muscle only used for food, moves by flapping together valves of shell, and thus throwing out the water.

"SINGLE SHELL."

Whole Shell. Very thin shell, sulphur yellow color, (draw).

Valves. Unequal in depth, flattened valve has a hole through which muscle extends to attach itself.

Compare the Oyster and Mussel.

Examine the oyster according to the plan used with the mussel, then arrange an outline as follows:

	OYSTER.	MUSSEL.
Shell.	irregular	nearly oval, smoother.
	beak at upper end	beak in middle, points toward front end.
	valves unequal	equal, upper and lower side.
	hinge with shelf	with tooth and cavity.
	one muscle scar	two muscle scars.
Animal.	mantle open	closed except two openings.
	one muscle	one muscle each side of beak.
	gill open	short siphon with "black head," two openings for water to and from gills.
	no foot	thick fleshy foot.

Habits. flat on bottom in shallow water. burrows in sand, siphon end up.

Lessons on Snails.

Ill. Gather a number of snails by scooping up the mud in ditches and on borders of ponds, keep them in jars of pond water with some water plants till habits are observed.

Live Snail Where does he move ? how does he move along ? how many feelers on the head ? touch them, what does he do ? at the base of the feelers find two black dots (eyes). Where is the mouth ? how does he use it ? Watch them come up to breathe, how do they do it? Watch during a number of days for other habits, laying of eggs, where? how? watch the eggs change. On what do they seem to feed? how much of the time are they feeding?

Shell. Collect a number of empty shells from the pond. What is the shape of the shell? color? what is the difference between the two ends? Begin at the pointed end (apex) and move the pencil along the deep grove to the opening, what kind of a line is it? Count the number of turns (whorls) in the shell. Move the pencil around to the outer edge (lip) of the opening, what is the shape? find lines on the whorls, what is their direction compared with the lip? what are they? Hold the shell spire up, and opening towards you, is the opening on the right or left hand?

Animal. Place the snail in alcohol till dead, then break the shell off, with what is the animal covered? how is it attached to the shell? Where is the breathing tube? which part of the animal is at the apex end?

Blackboard Outline.

THE FRESH WATER SNAIL.

Shell. Form . . . . . conical, rounded, or flattened.
Color . . . . . light or dark brown.
Lives . . . . . on water plants, stones, in mud.

Apex—pointed end of the shell.
spiral groove extends down to the opening.
six (?) turns or whorls in the shell.

Opening—at the lower end.
outer edge is the lip, of various shapes.
lines of growth parallel to the lip.
when held in position opening is on the right (?)

Animal. Soft body surrounded by a mantle,
held to shell by little muscles.
large creeping foot.
head with sucking mouth, feelers, and eyes.
breathes air by a tube or siphon.
lungs are in spire of the shell.

Compare the Snail Shells in form, size, color, number of whorls, shape of opening, right or left hand. *Compare* fresh water and land snails (found under dead leaves, rotten logs) in the same manner, also if possible fresh and salt water snails.

Consult Morse's "First Book in Zoology."

Compare the Mussel and Snail.

	Mussel.	Snail.
Shell.		
	two valves=bivalve	one valve=univalve.
	beak opposite the opening	apex opposite.
	lines of growth parallel to margin.	parallel to the lip.
Animal.		
	Mantle surrounds the soft parts, held to the shell by muscles, siphon for breathing.	
	no head	head, mouth, feelers, eyes.
	small foot	large creeping foot.

Lesssons on the Earthworm.

Ill. Place a worm in a saucer which is moist on the inside, or on a bit of newspaper. Also have one or two in a dish of moist earth for pupils to observe at different times. Encourage observation of the worms in the garden under boards, and on rainy days. Also have some worms which have been killed in alcohol.

Live Animal. What is its shape? color of upper and under sides? what other colors on any part? feel of it, with what covered? how does it move about? Which end is the larger?

How is the body divided? how many are there? of the same or different size? Find some rings thicker than the others (girdle), what color is it? does the girdle divide the worm into equal or unequal parts? what will you call the part front of it? the other part. On the front ring find a small hole, on which side is it? what is it? which lip is present? On the upper (dorsal) side look for a dark line, (food

tube) how far does it extend? What makes it dark colored? Just above this find another line (heart tube), what color is it? how far does it extend? how does it move? Is there any tube on the under (ventral) side?

Hardened Worm. What color is it? What is the difference in shape of the upper and under sides? Look for little dots or points (spines) on the lower side, how many rows? how far do they extend? rub the hand forward and backward over them, which way do they point? how does he use them?

What things have you seen the worm do in the earth?

Read or have read the chapter in Cooper's "Animals on land and sea." Teacher consult Hyatt's VII Science Guides.

Compare with other worms, leeches or blood-suckers from the ponds, hair worms found in the mud, in number of rings, parts about the head, parts on the sides of rings, other peculiarities.

Blackboard Outline.

Form . . . . . long, cylindrical, tapers at each end.
under side less curved than upper side,
Color . . . . . reddish brown on upper side, lighter below.
Movement . . . stretches out both ends of the body on the plate, on the earth clings by forward part and draws the rest along.
Parts. Head—small ring in front.
with mouth on lower side.
a lip above the mouth.
Body rings—very many, of nearly equal size.
Saddle or girdle—near front of body.
rings thicker than the others.
Food tube—a dark line along whole length of upper side.
Blood tube—a thin red line above food tube.
beats like a heart.

Uses. To loosen and work over the soil.
food for birds.

Lessons on a Crayfish.

Ill. Both live and alcoholic specimens should be used. Each pupil should examine, clean and mount one specimen, labelling the different parts.

Whole.

Form—long, cylindrical body, covered with a hard lime crust (crustacean).

Color—greenish black when alive, reddish when boiled.
Habitat—lives in fresh water.

Main Parts.

Body made of jointed rings (an articulate).
Rings grouped into two parts, head-thorax and abdomen.
Ten jointed legs attached to thorax.
An upper and under side.

Details of Parts

1. Head.

Beak—thick, sharp, toothed.	protects the brain.
Eyes—on stalks, black, compound.	see at a distance.
held back in a socket.	(diagram).
Small feelers—many joints branched	cavity serves as an ear.
open at base into a cavity	(diagram).
with a liquid in it.	
Large feelers—many joints, ½ length	feelers for food.
of the body.	
Jaws—hard, work sideway,	crush the food.
with hairy feelers, mouth	help taste food.
between.	
Helping jaws—two pairs, hairy	arrange the food like a
feelers.	tongue.

2. Thorax.

Foot-jaws—three pairs, gills and	move food and water.
paddles.	
Large claws—two, one with blunt	holding on.
teeth; other with sharp teeth.	tearing.
Small claws—four pairs, 7 joints to	crawling.
each, pinchers on two pairs,	move gills in water.
gills attached.	
Gills—branched, made of little tubes	purify blood by air in
packed against side of body.	the water.
covered by shield.	

3. Abdomen.

Rings—six rings, pair of paddles on	swimming.
each.	
Tail—broad, flat, with flaps.	hold egg

Internal Parts.

4. Stomach.
a large soft sac in a hard frame.
three prominent rounded teeth ("lady").
narrow at hind end.
intestine runs whole length of body to tail.

5. Liver.
   a greenish mass above the intestine.

6. Heart.
   a long sac on the back, nearly colorless blood.
   receives blood from gills and sends it over the body.

7. Brain—protected by beak.

Read chapter in Cooper, Morse's "First Book" for place of living, habits of getting food, defense, moulting, ways of catching, etc. Also references in Orton.

Animals like the Crayfish.

1. Lobster—larger than crayfish, lives in salt water.
   Shrimp—small, thin crust, often a long beak for defence.
   Hippa—thick, a long head thorax, narrow abdomen.

2. Crabs, head-thorax broad, abdomen small and folded under.
   Rock crab—greenish or brown, found among rocks.
   Fiddler crab—male with one very large claw, holes in mud.
   Hermit crab—long soft body, lives in old snail shells.
   Soft shell crab—two sharp spines on shell, used for food.
   Lady crab—spotted shell, hind claws for swimming.
   Horseshoe crab—shape of horse shoe, spine for a tail.

3. Beach fleas—small, flattened sideways, rings of thorax distinct, 14 legs, lives in sand.
   Water fleas—similar to above, small and active, live under sea weed, in fresh water also.
   Sowbugs—flattened, under boards, in cellars.

4. Barnacles—fixed, shell of several pieces, movable lid, several pairs long jointed hairy legs.
   Acorn barnacles—thick shell, on stones and piles.
   Goose barnacles—thin shell, on ship bottoms.

Read in Cooper, Orton, and Packard.

Lessons on an Insect.

Ill. A few live beetles in bottles, large dead specimen for each pupil. The Maybeetle is best for spring study, and a grasshopper for autumn.

BEETLE.

Whole. What is the shape? its color on upper and under sides? its covering? Of what is the body made up?

Main parts. How many? (teacher name). Which largest? smallest? (draw). How many pairs of wings? legs?

Head. Shape? which way move it? how many *eyes?* where? shape? color? (teacher show with glass that they are compound). How many *feelers?* where? of what made? Where are the *jaws?* which way do they move? What parts around the mouth? (draw these parts).

Thorax. Shape? edges smooth or notched? how many parts show on the upper side? on under side? Where are the *wings* attached? what kind is each pair? how is each pair shut? What lines or dots on the outside pair? how use each pair? to which pair are the *legs* attached? how many parts to each leg? with what are they covered? what is on the end of each? for what are the legs fitted? (draw).

Abdomen. Of how many rings is it made? which is the largest? color of under side? teacher lead pupils to find breathing pores.

Blackboard Outline.

Whole.

Oblong in shape, dark brown color, yellowish on under side, covered with a hard crust, hairy on under side, body made of rings which move on each other.

Main Parts.

Three parts—Head, Thorax, Abdomen.
Two pairs wings. Six pairs jointed legs.

Details of Parts.

1. Head.
Small, with a cap in front.
Moves up and down and forward.
Two compound eyes on side of head.
Two feelers between the eyes, jointed, knobs on end.
One pair of hard jaws, move sideways.
Two little helping parts about mouth.

2. Thorax.
Broad and smooth, marked with little dots.
Three parts, to show on upper side.

Wings. Outside pair hard, brown and glossy, meet in a line, marked with dots.
The other pair gauzy, with veins, folded under the others.
First pair attached to second part of the thorax.
The other pair attached to third part of the thorax.

Legs. One pair to each part of the thorax.
Each leg has three principal parts.

The first part large and smooth.
The second part with sharp notches for digging.
The third part made of little joints, ending with two claws.

3. *Abdomen.*
Made of rings, largest next thorax.
Yellowish in color.
Tip not covered by the hard wings.

Habits.

They fly at morning and evening twilight among the leaves of trees which they eat, in the daytime they hang among the leaves, often falling to the ground. They are attracted by the light, flying into the house. They dig into the ground to lay their eggs, the white grubs which hatch eat the grass roots. They change into beetles in May.

GRASSHOPPER.

Whole.

Long tubelike body; yellow, brown, or reddish.
Made of rings which move on each other.
The two sides of body are alike.

Main Parts.

Three parts—head, thorax, abdomen, 2 pairs wings, 3 pairs legs.

Details of Parts.

1. *Head.*
Long and narrow up and down.
Moves easily, up and down, sideways.
One pair long jointed *feelers.*
Two large *eyes,* (compound) on side.
Two brown *jaws,* move sideways.
Two pairs fine helping parts about mouth.

2. *Thorax.*
"Box-shaped," front part projects, under side flat and marked with lines.
Three parts show on under side.
Wing covers long, stiff, brown, many veins, rest straight along the body, attached to second part of thorax.
Under wings, transparent, veined, folded like a fan, attached to third part of thorax, used for flying.
Three pairs of *legs,* three parts to each leg, hooks on the end, hind pair long and strong for leaping.

3. *Abdomen.*
Long, made of rings, teacher show the breathing holes; on end are parts for depositing eggs.

Habits.

What they have seen, followed by reading Cooper, etc.

Compare the Beetle and Grasshopper.

Of what is the body made? how many main parts? how many pairs of wings? of legs? feelers? jaws? how many eyes? kind of wing covers, shape? kind of true wings, how folded? for what are legs fitted and how? Arrange on the blackboard in two parallel columns for comparison.

	May Beetle.	Grasshopper.
Body	made of many rings or segments.	
Main parts	three, head, thorax, and abdomen.	
	Two pairs wings and six jointed legs.	
Details.		
	one pair short feelers	one pair long feelers
	two eyes on side of head	two eyes on side of head.
	two jaws for biting	two jaws for biting
	wing covers, broad horny, curved	narrow, thick
	legs notched for digging	rest straight along the body
		hind legs long and stout for leaping.
Habits.		
	flying among trees in the evening.	jumping about in grass in daytime.
	young are grubs about in the ground.	young are small, and jumping about in the grass.

Dragon-fly.

Examine in the same order as before and then compare with the beetle and grasshopper, noticing especially the length of body, closeness of joints, length of feelers, size of eyes, size and kind of wings, number of veins, size and length of legs. Make a trip with net to the pond and dredge in the mud for the larvae of different dragon-flies, examine them for differences from the full grown insect. Observe them for a few days in the mud placed in a jar of water. Read from some book. Arrange as before.

Squash-bug.

Examine as before, and compare with those previously observed, noting in addition the shape of body, mouth parts, and kind of wings. Observe the young as they are found on squash vines and compare with the full grown insect.

House-fly.

Examine and compare as before, noting the distinctness of the parts, number and kind of wings, size of eyes, peculiar mouth parts. Observe the young as seen in maggots, and as it shuts itself up in a case (chrysalis).

Butterfly or Moth.

Examine and compare as before, noting in addition the shape of the body, size of the head, the kind of wings (teacher show scales with a glass) and position held, size of eyes, kind of feelers, tongue. Observe the young, as catterpillar, its parts and habits, and as chrysalis.

Bee or Wasp.

Examine and compare as before, noting especially the shape and size of the parts of the body, the size and kind of wings, number of wings, the shape and size of the feelers, the size of eyes, the small eyes, the mouth parts for biting, piercing and sucking, the length and covering of legs. Examine a piece of honey comb, with young bees if possible.

From these comparisons pupils should be led to select the properties that belong to all the insects observed, also to find the principal points in which insects differ. Read on the habits from books of which there are great numbers, Cooper, J. G. Wood etc.

Compare Beetle, Spider, and "Thousand Legs."

Of what is the *body* made? How many different *parts* to the body? of what size? How many *wings*? How many *legs*? to what attached? of what lengths? How many *eyes*? where? size? How many *feelers*? where? what kind of *jaws*? Where do they live and how do they work?

	Beetle.	Spider.	Thousand Legs.
Body.....made of rings with jointed legs.			
Main Parts.			
	3 unequal parts head, thorax, abdomen	2 unequal parts head, thorax, large abdomen	many equal rings. head and body rings.
	2 pair wings	no wings	no wings.
	3 pair legs to thorax	4 pair of legs of unequal length	1 pair legs to each ring.
Details.			
	2 large eyes	6-8 small eyes	2 small eyes.
	2 pair feelers	no feelers	1 pair feelers.
	horny jaws	hooked poison jaws	small jaws.

Habits.

under boards, stones, in water.	spins silk in webs or running on ground.	under boards, in damp ground.

Lesson on Fishes. Obtain fishes before they have been dressed for the market, also skeleton of a fish after cooking.

Observe the shape of the body, the parts on each side (bilateral symmetry); the covering of the body, arrangement and color of the *scales*, remove a scale, observe its shape, its border, effect of acid on it; the *jaws*, movable or not, whole or divided, peculiarities of the teeth; *eyelids* or protection for the eyes; position of *gill covers*, their structure, lifting them and opening the mouth at the same time, observe the color and number of the gill arches, their use, structure of the gills, warm or cold blooded; *lateral line*, where begin, end, course; *fins*, position and shape of dorsal, pectoral, ventral, anal, caudal fins, examine the structure of one. *Skeleton*, observe the *skull*, number of bones, their structure, amount of cartilage; the *vertebral column* of what composed, how united, spines on each. position of the canal, attachment of fins, parts of the fins.

Read on the habits of fishes, noises, air bladder, swimming, "school of fish," food, eggs. Impress adaptability of parts to function. Write a description of fish, arrange in outline qualities common to the fishes. Compare different fishes for the variations in any of the parts.

Lessons on Frogs and Toads. In the season observe them alive in jars of water or earth, also collect eggs, and watch the development of tadpoles. *Observe* the shape of the body, parts on each side, covering; *eyelids*, membranes over nostrils and ears; teeth on either *jaw*, peculiar tongue; observe the *gills* and caudal fins in tadpoles and then changes as they grow, warm or cold blooded; *legs*, number of toes on each foot, claws or not. *Skeleton*, the skull, shape, many or few bones, amount of cartilage; size of breastbone; length of ribs; compare bones of the legs and feet with those in human body.

Read on the habits, voices, food, means of protection, uses, eggs, metamorphosis. Write a description, also an outline of qualities common to "Batrachians (Amphibians)." Compare with fishes. Compare the common batrachians,

Salamanders—lengthened body, rounded tail.

Newts—lengthened body, tail with a caudal fin.

Frogs—tailless, teeth on upper jaw, toes webbed, aquatic, (leopard frog, green frog, bullfrog, pickerel frog.)

Toads—tailless, no teeth, warty skin, terrestrial.

Tree-toads—tailless, fingers and toes dilated forming a viscous disk, arboreal.

Lesson on Snakes and Turtles. Collect live turtles.

Observe the shape, parts on each side, covering, arrangement of *scales* on the head, upper and under side of the body, adaptation of color of snakes to habitat; *eyelids* in each; *jaws*, lips, teeth; method of breathing, warm or cold blooded; *legs*, number of toes, claws. *Skeleton*, shape of skull, breastbone and ribs in turtle, compare limbs with previous animals and with human body.

Read on the habits, voices, food, poisonous snakes, eggs. Write a description, also an outline of qualities common to "Reptiles." Compare with the previous. Compare the common reptiles.

Snakes—long, cylindrical body, limbless.

(Lizards)—body with a long tail.

Turtles—body enclosed in a thick shell. Pond turtles (shell highest in middle, 12 lower plates). Mud turtles (shell highest behind middle, less than twelve lower plates). Snapping turtles (shell highest front of middle, jaws strongly hooked, under shield cross shapped.)

(Alligators)—body thick scaled, teeth in sockets.

Lesson on Birds. Use the birds known to the pupil, a stuffed bird, collect the different kind of feathers, claws, bones. *Observe* the shape of the body, parts on each side, covering. Name the three kinds of *feathers* and their position. Examine one of the large *quill feathers*, the stem consists of the tube and the shaft, shape of each? inside of each? the expanded part is the vane, composed of barbs, what is their shape? how many rows? under the lens find the barbules, from what do they extend? how many rows? how held together? Draw the feather. How do the do the other feathers differ from these?

Observe the facts about the beak, nostrils, eyes, and ears. How many divisions to the fore-limb or *wing?* count the quill feathers attached to each part. How many quills form the *tail?* how arranged? What feathers on the *legs?* how far do they extend? with what is the rest of the legs covered? How does a bird breathe? warm or cold blooded? *Skeleton.* Character of the bones, the peculiarity of the vertebral columns, shape of breastbone and its use, attachment of wings and legs, compare the limbs with those of other animals.

Observe and *read* on the habits, colors of birds, moulting, voices, nests and eggs, eating and drinking, migrations. Write a description, an outline of qualities common to birds. Compare with previous. Compare the bills, legs, and toes of the following birds, ducks, herons, hens, doves, hawks, parrots, woodpeckers, robbins. Group the common birds according to the above marks.

Comparison of Birds. (1) Compare the ostrich (picture) and the common birds in wings, breastbone, feathers, and legs. Show

adaptation to life. (2) Compare the following groups of birds in wings, tail, legs, tarsi, toes, claws, bill, cere, emphasizing adaptations, sketching as directed (*Aquatic birds*—loon; gull, tern; duck. *Terrestrial birds*—heron, rail, plover, sandpiper; grouse, quail, poultry; pigeons. *Aerial birds*—hawk, owl, eagle; woodpecker; parrot; humming bird, kingfisher, cuckoo; perching birds. Write the group marks in the laboratory book with the sketches.

Lessons on Mammals. Use the cat, dog, and other well known illustrations.

(1) *Observe* the general shape of the body, parts on each side, the covering, examine a hair under the microscope, special hairs and their use, teeth, the four kinds with uses, membrane lining the mouth, outer ear, eyelids; how breathe, warm or cold blooded; parts of the limbs, compare with previous and with human body, care of the young. Write an outline of qualities common to mammals. (2) Compare the parts of the limbs, and the mouth parts of squirrels, moles, bats, whales, elephants, horses, dogs, monkeys, man. Adaptation of parts to life. (3) Make a careful study of the skeletons of mammals for *homologous* parts and their adaptations. Also compare for *analogous* parts.

LANGUAGE AND DRAWING IN ALL GRADES.

ANIMAL KINGDOM. SUB-KINGDOM. CLASS. ORDER

I. Primitive animals (Protozoa).
II. Sponges (Porifera).
III. Polyps and Jellyfish (Coelenterata).
IV. Spiny skinned animals (Echinoderms).
Starfish, sea-urchin, sea-cucumber.
V. Worms (Vermes).
1. Flat worms (Plathelminthes).
2. Round worms (Nemathelminthes).
3. Ringed worms (Annelida).
VI. Jointed animals (Anthropoda).
1. Crustacea; crabs, lobsters, etc.
2. Arachnida; spiders, scorpions, etc.
3. Myriapoda; thousand-legged worms.
4. Insecta; bee, bug, butterfly, etc.
VII. Mollusks. (Mollusca.)
1. Bivalves (Lamellibranchs).
2. Univalves (Gasteropods).
3. Cuttle fish (Cephalopods).
VIII. Tunicates.
IX. Vertebrates.
1. Fishes; sharks, bony fishes, etc.
2. Amphibians; Salamanders, frogs, etc.
3. Reptiles; snakes, turtles, etc.
4. Birds.
a. Running birds; ostrich.
b. Flying birds; gulls, robin, etc.
5. Mammals.
a. Ornithorhynchus.
b. Pouched; opossum, kangaroo.
c. Toothless; armadillo.
d. Whales; whalebone and sperm whale
e. Hoofed; cow, horse, etc.
f. Thick skinned (with trunk); elephant
g. Gnawers (Rodents), rats.
h. Insect-eaters (Insectivora), mole.
i. Bats.
j. Flesh-eaters (Carnivors), cat, dog.
k. Monkeys.
l. Man.

NATURAL PHENOMENA.

Have oral and written language work in connection with the following:

First and Second Years.

Lead children to observe the different forms of water in the air, *e. g.*, dew and frost. Where, how disappear, think of use or injury; fog and mist, when and where appear, how disappear; clouds as mist floating in the air, raindrops from the clouds, snowflakes, shapes of crystals (sketch); teach to use the terms in describing the weather from day to day, "a frosty morning," "cloudy day," "clear day" etc; observe course of the sun during the day, the value of the light and heat; the position and phases of the moon, its light in the night. In Autumn notice insects going into ground, leaves changing and falling to cover plants, seeds dropping or carried by wind, etc. In Spring notice also awakening of nature, buds springing, melting of snow, etc.

Third Year.

Teach some of the properties of *air* (it cannot be seen, transparent, can be felt, show by different illustrations that air when heated rises). Show by many illustrations that moisture passes into the air, call it vapor (damp slate; wet cloth, water on window, etc). Heat changes moisture into vapor (by fire, by heat of sun from rivers, ponds, grass, etc.); cool air changes the vapor into drops of water (vapor from boiling water, breathe on a cool glass, water on window, etc.); observe the forms of water, dew and frost on cold grass, etc.; effect of warm wind or heat of sun, clouds in cold air made of fine drops, larger drops form rain, crystals of snow, effect of heat of sun and wind; fog and mist in a similar manner. Teach to read the thermometer and tell what it means, notice the gradual change in the month, make a simple weather record each day. Lead them to think of life in winter—protection of buds, seeds in the ground, homes of animals, winter birds, how animals keep warm—

In Autumn note changes when winter approaches, preparations for winter by nature and man, changes in temperature, rising and setting of sun. Look for first frosts, where, how disappear, etc.

In Spring (we do not have much *real* Spring here) notice preparations tor bursting forth of life, changes in length of days, in temperature, return of birds etc.

Fourth Year.

At regular times each day have pupils observe and record the temperature of the air in the schoolroom and outdoors, connect with the sun and the direction of the wind. Teach vapor as invisible particles of water floating in the air, *e. g.* Water standing in

a dish in the room, measure its depth at long intervals, think what becomes of the water, the size of the particles, where they are; water standing on sidewalks and concrete, dew on grass, a lump of moist earth in a dish in the sunlight. Note from time to time vapor reappearing as cloud and fog, mist and rain, dew and frost, snow and ice, teach to associate with temperature, apply to geography by use of pictures and reading to show the forms common in hot, temperate and cold regions; in river valleys and on mountain peaks.

Observe course of sun by marks in schoolroom etc.

Fifth and Sixth Years.

Evaporation. Water in a saucer disappears, wet cloth dries, others of same kind; think of small particles of water passing into and mixing with the air; call this invisible water in the air vapor, the change evaporation. What becomes of water after a shower? in ponds, etc., dew and frost. *Illustration*—Water in direct sunlight and out of it, wet cloth in wind and out of it. Note the time it takes to dry, state effects of heat and wind, apply to dew, frost, snow, ice, wet ground, etc.; other common illustrations. Why does evaporating ice cool a room or ice chest? *Illustration*—Fresh leaves under a dry tumbler, moisture on side of tumbler, think whence it came, value to the plant, watering plants. *Illustration*—Perspiration, use to man, breathe on cool glass surface. Combine and think of all places from which vapor gets into the air. (Written work from a series of questions.)

Condensation. Tumbler with ice in it standing in a room, observe moisture collecting on outside, think of vapor of air cooled (condensed) by cold tumbler, apply to moisture and frost on window, dew or frost on grass, etc.; think of small particles collecting (condensing) into drops. *Illustration*—Heat water in test tube, vapor next to water invisible (steam), condenses in cool air (steam-fog), soon changes to vapor again. *Observe fog* some morning over low places, cool vapor condenses into fine drops, sun or wind changes it to vapor. *Observe cloud* in upper air, vapor rises into cooler air, condenses, sun or wind often changes it to vapor, when more condensed than air can hold it mists (fine drops) or rains, particles attracted into globules, note ground in winter open to receive rain for springs. *Observe frost or snow*, crystals of water, note temperature 32° or lower, water condensed into a solid (frozen). *Observe ice*, crystals packed together in a mass, ice lighter than water, rises to top, protects life, etc., in water. *Illustration*—Freeze water in a closed glass tube, breaks, ice crystals take more room than same amount of water, bursts water

cracks in rocks, helps make soil. Compare hail

and snow, drops of water frozen, fine drops of mist frozen, value of snow in winter. (Written work).

Keep a daily weather chart on the board, noting time of rising and setting sun (almanac), temperature, direction and kind of wind, amount of moisture in the air (a. m. and p. m.). At close of week note general facts and changes, relation of facts one to the other, influence on the surroundings. Observe change in the position of rising and setting sun, its effects on the weather. (The foregoing may be suggestive of many other experiments and illustrations valuable in this connection. See Rick's Object Lessons. Jackman's Nature Study).

Seventh and Eighth Grades.

Continue work of Sixth and Seventh grades, using similar illustrations.

Study *Physical and Chemical Forces.* Make the study without text-books and without technicality, making the work as simple and direct as possible. Action of *cohesion* and *adhesion* on common substances, *properties* of matter, such as hardness, brittleness, elasticity, etc., practical uses; *gravity*, and its application to weight, support of bodies, balances, *simple machines*; *pressure of water* and air, pumps and barometer; *heat* and its effects, thermometer, steam engine, etc.; simple lessons on combustion, chemistry of foods, of cleansing, of *acids* or minerals and metals, of pure and impure air; simple facts of *magnetism*, *electricity*, *light* and *sound*.

This work must be done experimentally just as far as possible. No other kind will do any good whatever. Where teachers lack appliances, select the most simple parts of the work the appliances for which the boys of the class may be able to make with the assistance of the teacher, then require the investigation to be done by the pupils with accompanying note book work.

GENERAL LIST

Reference Books for Teachers and Pupils.

(To be found in Teachers' Library.)

PLANTS.

No.

Goodale. Concerning a few common plants....662
Newell. From seed to leaf. Two copies....675–693
Newell. From flower to fruit. Two copies....674–694
Flagg. A year among the trees....686
Deane. Little talks about plants....691
Bergen. Glimpses at the plant world....692
Creevery. Recreations in botany....695
Pratt. Little flower folks, 2 vols....699–700
Hale. Little flower people....1601
Hooker. Botany. Three copies....1616–17–18
Gray. Manual of botany....629
Gray. School and field book of botany....630
Coulter. Manual of botany....631
Frye. Child and nature. Five copies....712–713–714–677–726
Nelson. Wonders of the vegetable world....899
Buckley. The fairy land of science....1653
Buckley. Moral teachings of science....1654

MINERALS.

Le Conte. Elements of geology....624
Shaler. First book in geology....625
Shaler. Story of our continent....626
Reclus. The history of a mountain....627
Crosby. Common minerals and rocks....664
Hyatt. About pebbles....665
Richards. A first lesson on minerals....666
Agassiz. Geological sketches, 2 vol....668–669
Greene. Coal and the coal mines....689
Geikie. Geology. Three copies....1628–1629–1630
Clapp. Observation lessons on common minerals....1641
Kingsley. Madam how and lady why....1661

ANIMALS.

Steele. Zoology....648
Colton. Zoology....649

No.
Wood. Natural history.....650
Ricks. Natural history object lessons.....651
Wright. Seaside and wayside, 4 vols.....652–53–54–55–56
Johonnot. A natural history reader.....657
Hyatt. Insecta. Two copies.....658–1649
Hyatt. Worms and crustacea.....659
Agassiz. A first lesson in natural history.....660
Hyatt. The oyster, clam, and other mollusks.....663
Smiles. The Scotch naturalist.....667
Flagg. A year with the birds.....683
Merriman. Birds through an opera glass.....684
Burroughs. Birds and bees.....685
Emerton. Spiders, their structure and habits.....687
Bamford. Up and down the brooks.....688
Kelley. Leaves from nature's story book, 3 vols.....696–697–698
Buckley. Life and her children.....1652
Scudder. Life of a butterfly.....1656
Jackman. Nature study.....1660
Morley. A song of life.....1662
Frye Child and nature. Five copies.....712–713–714–726–677
Bilby. Young folks' natural history.....721

NATURAL SCIENCE.

(*City Library.*)

GENERAL WORKS.

	No.
Hooper. Child's book of nature	j Q 424

ASTRONOMY.

Lockyer. Astronomy. [science primers]	Q 1528
Proctor. Other worlds than ours	Q 1716
Serviss. Astronomy with an opera glass	Q 1814
Stewart. Sun and earth	Q 1854

BOTANY.

Bessey. Botany	Q 2085
Hooker. Botany [Science primers]	Q 2424
Manton. Field botany: hand-book for the collector	Q 2555
Candolle. Origin of cultivated plants	Q 3140
Cooke. Fungi: their nature and uses	Q 3187
Huxley. On yeast	Q 3438
Trouessart. Microbes, ferments, and moulds	Q 3906
Allen. Colors of flowers	Q 4015
Henslow. Origin of floral structure	Q 4404
Rand. Popular flowers and how to cultivate them	Q 4728
Vick. Flower and vegetable garden	Q 4934

GEOLOGY.

Croll. Climate and time in their geological relations	Q 7206
Dana. Text book of geology	Q 7214
Dawson. Story of the earth and man	Q 7216
Lyon. Hollow globe	Q 7538
Taylor. Stone age: past and present	Q 7904
Winchell. Sparks from a geologist's hammer	Q 7975
Wright. Ice age in North America	Q 7984
Owen. Geological survey of Nebraska	Q 8660

NATURAL HISTORY.

GENERAL WORKS.

	No.
Hooker. Child's book of nature	j Q 424

ZOOLOGY.

Agassiz. Methods of study in natural history	R 1005
Bamford. Look-about club and the curious live things they found	j R 1048
Beangrand. Walks abroad of two young naturalists	j R 1066
Darwin. What Darwin saw in his voyage around the world	j R 1216
Darwin. Feathers, furs and fins	j R 1285
Heilprin. Geographical and geological distribution of animals	R 1397
Miller. Little folks in feathers and fur	j R 1594
Miller. Queer pets at Marcy's	j R 1593
Morris. Anecdotes in natural history	j R 1619
Packard. Zoology	R 1667
Pettigrew. Animal locomotion	R 1684
Reid. Stories about animals	j R 1736
Romanes. Animal intelligence	R 1757
U. S. Report of the geographical and geological surveys west of the 100th meridian	V 5
Zoology	R 1915

MARINE ZOOLOGY.

Dana. Corals and Coral Islands	R 3216
Kingsley. Wonders of the shore	R 3477
Romanes. Jelly-fish, star-fish, and sea-urchins	R 3756

ENTOMOLOGY.

Bamford. My land and water friends	j R 4049
Bamford. Up and down the brooks	j R 4048
Hook. Little people	j R 4423
Lubbock. Ants, bees, and wasps	R 4536
Lubbock. On the senses, instincts, and intelligence of animals, with special reference to insects	R 4537
Manton. Insects; how to catch and how to prepare them for the cabinet	R 4555

THE LIBRARY OF THE
OCT - 5 1933
UNIVERSITY OF ILLINOIS

ORNITHOLOGY

	No.
Burroughs. Birds and bees	R 6124
Burroughs. Wake Robin	R 6125
Merriman. Birds through an opera glass	R 6583
Miller. Bird ways	R 6593
Trumbull. Names and portraits	R 6904

MAMMALIA,

Baker. Wild beasts and their ways	R 7045
Kingston. Stories of the sagacity of animals	j R 7477
Knox. Dog stories and dog lore	
Miller. Stories of the cat and her cousins	j R 7595
Schmidt, The mammalia	R 7798
Weir. Our cats and all about them	R 7985

MAN.

Adams. The continuous creation	W 1008
Cook. Heredity	R 10188
Fiske. Excursions of an evolutionist	R 10293
McCosh. The religious aspect of evolution	R 10544
Burge. Pre-glacial man and the Aryan race	R 11123
Joly. Man before metals	R 11463
Morris. Aryan race; its origin and its achievements	R 11618
Quatrefages. The human species	R 11722
Short. North Americans of antiquity	R 11815
Taylor. Origin of the Aryans	R 11874
Taylor. Anthropology	R 11908
Wright. The ice age in North America and its bearings upon the antiquity of man	Q 7984
Clodd. Childhood of the world	R 12177

UNIVERSITY OF ILLINOIS-URBANA
3 0112 105209297